

THE BRITISH SOCIETY FOR THE PROMOTION
OF VEGETABLE RESEARCH

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NATIONAL VEGETABLE RESEARCH
STATION

WELLESBOURNE . . . WARWICK

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CONTENTS

	Page
The Constitution of the National Vegetable Research Station	iii
LIST OF :	
GOVERNING MEMBERS OF THE SOCIETY	iv
MEMBERS OF THE EXECUTIVE COMMITTEE and the SUB-COMMITTEES	v
STAFF	vi
REPORT OF THE DIRECTOR :	
Development	1
Staff	1
Research	3
Farm	8
Research Reports and Reviews	
PLANT BREEDING <i>J. C. Haigh</i>	11
Synonymy in lettuce varieties <i>L. E. Watts</i>	16
CHEMISTRY <i>F. Haworth</i>	37
The effect of 'Krilium' on the yield of certain vegetable crops. II <i>F. Haworth and J. A. Nelder</i>	40
IRRIGATION <i>E. J. Winter</i>	48
ENTOMOLOGY <i>D. W. Wright</i>	53
PLANT PATHOLOGY <i>W. G. Keyworth</i>	58
WEED INVESTIGATIONS <i>H. A. Roberts</i>	62
STATISTICS <i>J. A. Nelder</i>	64
THE WEATHER DURING 1954 <i>Josephine I. E. Rubio, E. J. Winter and G. Stanhill</i>	65
LIBRARY <i>Pamela Scarborough, Christine M. Rowe and H. A. Roberts</i>	68
PUBLICATION RECORD	69
MAPS	
Wellesbourne	70
Paglesham	71
Route Map	72

THE CONSTITUTION OF THE NATIONAL VEGETABLE RESEARCH STATION

The National Vegetable Research Station (N.V.R.S.) at Wellesbourne, Warwickshire, and its Sub-Station at Paglesham, Essex, were established under a Governing Body incorporated on 28th September, 1949, as a company limited by guarantee, not having a share capital, and having the title 'The British Society for the Promotion of Vegetable Research,' with its registered office at Wellesbourne.

The members of the Governing Body, twenty-three in number, include nominees of the two Agricultural Departments of Great Britain, of the Department of Scientific and Industrial Research, of various learned societies, universities and institutions concerned with horticulture, of vegetable producers (through the National Farmers' Unions of the two countries and the National Allotments and Gardens Society) and of trade interests.

The properties at Wellesbourne and Paglesham are leased to the Society by the Ministry of Agriculture and Fisheries. At the outset the Society depends for its funds on grants from this Ministry, except that if any stations are established or work is conducted in Scotland, grants will be receivable also from the Scottish Agricultural Advisory Council. Both Agricultural Departments are advised by the Agricultural Research Council (A.R.C.) who have the scientific oversight of the work and staff.

GOVERNING MEMBERS OF THE SOCIETY

Appointed by the Minister of Agriculture and Fisheries :

- Professor K. MATHER, Ph.D., D.Sc., F.R.S., Department of Genetics,
The University, Edgbaston, Birmingham, 15.
- Professor T. G. B. OSBORN, M.A., D.Sc., Department of Botany, The University, Oxford.
(Until 30/9/53).
- Sir EDWARD SALISBURY, C.B.E., D.Sc., LL.D., F.R.S., F.L.S., V.M.H.,
Royal Botanic Gardens, Kew, Surrey.
- H. V. TAYLOR, Esq., C.B.E., D.Sc., A.R.C.S., V.M.H., (Chairman),
Preston Grange, Barnet Road, Potters Bar, Middlesex.
- Professor P. T. THOMAS, B.Sc., Ph.D., Department of Agricultural Botany,
The Institute of Rural Science, University College of Wales, Penglais, Aberystwyth.
(From 1/10/53).

Appointed by the Secretary of State for Scotland :

- R. L. SCARLETT, Esq., C.B.E., C.D.A., Sweetthope, Musselburgh, Midlothian.

Appointed by the Department of Scientific and Industrial Research :

- R. G. TOMKINS, Esq., M.A., Ph.D., Ditton Laboratory, East Malling, Kent.

Appointed by the University of London :

- Professor J. W. MUNRO, C.B.E., M.A., D.Sc., Frognall Cottage, Sunninghill, Berks.

Appointed by the University of Reading :

- Professor R. H. STOUGHTON, D.Sc., A.R.C.S., V.M.H., Department of Horticulture,
The University, Reading.

Appointed by the University of Cambridge :

- J. BARKER, Esq., M.A., Ph.D., F.R.S., The Botany School, Cambridge.

Appointed by the University of Bristol :

- Professor T. WALLACE, C.B.E., M.C., D.Sc., F.R.I.C., V.M.H., F.R.S.,
University of Bristol Research Station, Long Ashton, Bristol.

Appointed by the University of Edinburgh :

- ALEXANDER NELSON, Esq., Ph.D., D.Sc., F.R.S.E.,
University Department of Botany, at Royal Botanic Garden, Edinburgh, 4.

Appointed by the Royal Society :

- Professor W. BROWN, M.A., D.Sc., F.R.S., The Bush, Haddenham, Aylesbury, Bucks.

Appointed by the John Innes Horticultural Institution :

- C. D. DARLINGTON, Esq., D.Sc., F.R.S., Bayfordbury, Herts. (Until 7/10/53).
K. S. DODDS, Esq., Ph.D., D.Sc., Bayfordbury, Herts. (From 25/3/54).

Appointed by the National Farmers' Union :

- A. H. BOARDMAN, Esq., A.M.I.B.A.E., Lunts Farm, Paglesham, Rochford, Essex.
- A. A. CLUCAS, Esq., Red Trees, Lathom, Ormskirk, Lancs.
- G. G. HOLE, Esq., Pakyns, Hurstpierpoint, Sussex.
- J. LAITY, Esq., Polkinghorne, Gwinear, Hayle, Cornwall.
- W. F. SWIFT, Esq., Avon Cottage, Fladbury, Pershore, Worcs.

Appointed by the National Farmers' Union of Scotland :

- DAVID LOWE, Esq., C.B.E., Elvingston, Gladsmuir, East Lothian.

Appointed by the Horticultural Trades' Association :

J. S. W. CRACKNELL, Esq., V.M.H., c/o Watkins and Simpson Ltd., 27 Drury Lane,
London, W.C.2.

Appointed by the Royal Horticultural Society :

F. A. SECRETT, Esq., C.B.E., F.L.S., V.M.H., Hurst Farm, Milford, Godalming, Surrey.

Appointed by the National Allotments and Gardens Society :

Professor J. CALDWELL, Ph.D., D.Sc., Hatherly Biological Laboratories,
Prince of Wales Road, Exeter.

Appointed by the Seed Trade Association of the United Kingdom :

A. L. DEAL, Esq., c/o W. W. Johnson and Son Ltd., Boston, Lincs.

The Executive Committee

Professor W. BROWN	Professor J. W. MUNRO
J. S. W. CRACKNELL, Esq.	F. A. SECRETT, Esq.
G. G. HOLE, Esq.	Professor R. H. STOUGHTON
DAVID LOWE, Esq. (Chairman)	W. F. SWIFT, Esq.
Professor K. MATHER	Professor T. WALLACE

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A. A. CLUCAS, Esq.	Professor R. H. STOUGHTON
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DAVID LOWE, Esq.	Dr. R. G. TOMKINS
Professor K. MATHER	Professor T. WALLACE
Professor J. W. MUNRO	

Co-opted :

C. E. HUDSON, Esq., N.D.H., V.M.H., Ministry of Agriculture, 2 Cambridge Terrace,
Regent's Park, London, N.W.1.

Buildings Sub-Committee

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Professor J. W. MUNRO	Professor T. WALLACE
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J. LAITY, Esq.	

Co-opted :

E. R. HOARE, Esq., B.Sc. (Eng.), M.I.E.E., National Institute of Agricultural
Engineering, Wrest Park, Silsoe, Beds.

STAFF

Director :

JAMES PHILP, B.Sc. (Glas.), Ph.D. (Lond.), F.L.S.

- Plant Breeding :** J. C. HAIGH, B.Sc., Ph.D. (Lond.), A.R.C.S., A.I.C.T.A.
 A. G. JOHNSON, B.Sc. (Lond.), Ph.D. (Wales).
 H. HOLLAND, B.Sc. (Wales).
 L. E. WATTS, B.Sc. (Wales).
 E. M. WATSON, N.D.A., C.D.A. (Glas.).
 G. J. FAULKNER. (Appointed 1/1/54)
Assistants : Miss C. H. BEARDALL, Dip. Hort. (Nott.).
 Miss C. F. GANDERTON. Miss K. HIGHMAN.
 Miss W. HORN. Miss J. M. H. INSLEY (Appointed 9/8/54)
- Chemistry :** F. HAWORTH, B.Sc., Ph.D. (Liverpool), Dip. Ag. Sci. (Cantab.), A.R.I.C.
 E. E. H. PITT. (Appointed 10/5/54)
Assistants : Miss A. BURGESS.
 Miss J. WAGHORN. (Appointed 13/9/54)
- Irrigation :** E. J. WINTER, M.C., M.Sc. (Bristol).
 Miss E. M. CANAVAN, B.Sc. (Edin.). (Resigned 31/8/54)
 P. J. SALTER, M.Sc. Hort. (Nott.). (Appointed 27/9/54)
Assistants : B. G. HUNT. (National Service 10/11/53)
 A. MORGANS. (National Service 8/12/53)
 Miss J. I. E. RUBIO.
 Miss J. SMITH. (Appointed 4/1/54)
 J. PARKER. (Appointed 6/9/54)
- Entomology :** D. W. WRIGHT, M.A. (Cantab.).
 J. A. DUNN, M.Sc. (Dunelm).
 G. A. WHEATLEY, B.Sc. (Dunelm).
 J. Y. RITCHIE, B.Sc. (Glas.). (Resigned 31/10/53)
 Miss D. D. BOWE, B.Sc. (Dunelm).
 J. A. HARDMAN, B.Sc. Hort. (Nott.). (Appointed 19/7/54)
Assistants : H. I. SMITH. Miss E. A. DEARDEN. Miss A. SARGENT.
- Pathology :** W. G. KEYWORTH, B.Sc., Ph.D. (Lond.), A.R.C.S., D.I.C.
 J. A. TOMLINSON, B.Sc., Ph.D. (Birm.).
 A. G. CHANNON, B.Sc. (Aberdeen).
 Miss J. S. HOWELL, B.Sc. (Birm.).
 Miss D. E. FISHER, B.Sc. (Lond.), A.R.C.S. (Working under A.R.C. grant)
 J. M. WAY, B.Sc. (Lond.). (Appointed 8/3/54)
Assistants : Miss J. THORPE.
 Miss J. CARPENTER. (Appointed 12/10/53)
 Miss A. P. WARD, N.D.D.H. (Studley).
 (Appointed 27/7/54 under A.R.C. grant)
- Weed Ecology :** H. A. ROBERTS, B.Sc. (Manc.).
 Miss M. E. SMART, B.Sc. (Lond.).
Assistants : Miss P. SCARBOROUGH, Dip. Hort. (Studley).
 (Resigned 12/7/54)
 Miss C. ROWE. (Appointed 12/7/54)
- Vegetable Washing :** M. J. W. WEBB, B.Sc. Hort. (Nott.).
- Statistics :** J. A. NELDER, M.A. (Cantab.).
 D. COOKE, B.A. (Oxon.)
Assistants : Miss J. FARNSWORTH.
 Miss H. RUSSELL. (Appointed 11/8/54)
- Recorder :** Miss B. M. THOMAS. (Resigned 30/11/53)
- Farm :** *Farm Manager :* T. J. NORWOOD.
Foreman : E. F. ROBINSON. (Resigned 12/3/54)
- Administration :** *Secretary :* J. C. WILKINS, LL.B. (Lond.), F.C.I.S.
Accounts Clerk : J. H. L. BRIDGEWATER.
Director's Secretary : Miss E. B. FORRESTER. (Appointed 13/10/53)
Clerical Assistants : Miss J. M. LAMB. Miss M. A. WARR.
 Miss S. B. TOOKEY. (Appointed 26/1/54)

REPORT OF THE DIRECTOR

DEVELOPMENT

In general, good progress was made on the building development which began in June 1953 although the rate of progress in some cases was disappointing. The farm stores, including a portion modified and fitted for use as temporary laboratories, were completed in June 1954. Three sections of research, Chemistry, Entomology and Pathology, transferred to these additional laboratories, thus obtaining more space and better facilities for their work and allowing more accommodation for the other research sections in the original wooden temporary laboratories. The Library was also transferred to the new building. The farm stores, although depleted by the part converted into laboratories, formed a welcome acquisition to the farm section.

During September 1954, the grading, washing and packing shed, the building for threshing and storage of vegetable seeds, and the canteen were completed. At this time the block for housing implements and machinery, and a workshop were about halfway towards completion. Work began on the erection of two pairs of cottages in May and of a farm manager's house in July 1954.

The glasshouses, work upon which started in December 1953, were nearing completion by the end of September 1954 and some of them were brought into use during the summer. The boiler house and the low pressure steam heating installation were well advanced and were due to be functioning by mid-October. The potting shed and other buildings associated with the glasshouses were nearly half completed.

Hard-core service roads to the above buildings were laid and they will be surfaced with asphalt as the buildings are completed. It is expected that this phase of the building development will be finished by the middle of 1955.

The installation of water mains and irrigation sub-mains with pumping apparatus, and the building of a pump house and a 20,000 gallon tank were finished in June 1954, only one month later than the scheduled time. The mains supply of water was a great asset to the station and it also enabled the new sewage disposal works to be brought into use. The irrigation sub-mains were used with advantage in the establishment of transplanted brassicas during June but owing to the abnormally wet weather during the remainder of the season, irrigation was a service which was not required again.

STAFF

Additions to the staff were made during the year but, on the farming side, recruitment of skilled workers still remained difficult.

Appointments

Mr. P. J. Salter was appointed on 27th September, 1954, as successor to Miss E. M. Canavan in the Irrigation Section. Mr. Salter had previously been engaged in research on the irrigation of tomatoes under glass, at Nottingham University.

Miss M. E. Smart was appointed as Assistant Experimental Officer in the Weed Ecology Section on 1st October, 1953.

Mr. G. J. Faulkner was appointed on 1st January, 1954, as Assistant Experimental Officer in the Plant Breeding Section.

Mr. J. M. Way was appointed as Assistant Experimental Officer in the Plant Pathology Section on 8th March, 1954.

Mr. E. E. H. Pitt was appointed on 10th May, 1954, as Assistant Experimental Officer in the Chemistry Section.

Mr. J. A. Hardman was appointed in succession to Mr. J. Y. Ritchie as Assistant Experimental Officer in the Entomology Section on 19th July, 1954.

Nine Scientific Assistants were appointed during the year :

Miss W. Horn, Plant Breeding
Miss J. Smith, Irrigation
Miss P. Ward, Plant Pathology
Miss H. Russell, Statistics

Miss J. Carpenter, Plant Pathology
Miss C. M. Rowe, Weed Ecology
Miss J. M. H. Insley, Plant Breeding
Mr. J. Parker, Irrigation ; and
Miss J. Waghorn, Chemistry

11 students were employed to assist in research during the University summer vacation.

Miss E. B. Forrester was appointed as Director's Secretary on 13th October, 1953, in succession to Miss K. Ablett.

Miss S. B. Tookey was appointed as a Clerical Officer on 26th January, 1954.

Resignations

Miss E. M. Canavan resigned on 31st August, 1954, in order to be married.

Mr. J. Y. Ritchie resigned on 31st October, 1953, and took up work at the School of Agriculture, University of Nottingham.

Miss B. M. Thomas (Recorder) resigned on 30th November, 1953, on the occasion of her marriage, and Miss P. Scarborough (Scientific Assistant) resigned on 12th July, 1954.

National Service

Mr. B. G. Hunt and Mr. A. Morgans, Scientific Assistants, left to carry out their National Service training.

Members of the research staff attended a number of conferences during the year. The Director and Mr. H. A. Roberts attended the British Weed Control Conference held in Margate in November 1953, and the Director read a paper on 'The weed problem in vegetable production.' Dr. W. G. Keyworth and Dr. J. A. Tomlinson attended the N.F.U. Watercress Conference held in Guildford in March 1954, and Dr. Tomlinson read a paper on 'Crook root disease.' Mr. E. J. Winter read a paper on 'The regime approach to irrigation' at the Horticultural Education Association Symposium on Irrigation held at the School of Agriculture, University of Nottingham, Sutton Bonington, in April. He also demonstrated soil moisture meters and some irrigation techniques at the Craftsmanship Conference of the above Association held at Sutton Bonington in September. The Director, Dr. J. C. Haigh, Mr. H. Holland, Dr. A. G. Johnson and Mr. L. E. Watts attended the Plant Breeders' Conference, sponsored by the A.R.C. and held at Belfast in July. Dr. Keyworth attended the Mycological Conference held in London in July. Mr. D. W. Wright attended functions connected with the 150th Anniversary of the Royal Horticultural Society in July. Mr. Wright, Mr. J. A. Dunn, Dr. Keyworth, Dr. Tomlinson, Mr. A. G. Channon and Miss D. E. Fisher attended the Jubilee Meeting of the Association of Applied Biologists held in London in September, and exhibits from the Entomology Section and Pathology Section were staged at the Conversazione.

Mr. G. A. Wheatley was awarded a W. K. Kellogg Foundation Fellowship and in consequence was in the U.S.A. from 1st June to 30th November, 1954. During that period he carried out research on the control of the imported small cabbage white caterpillar with dust insecticides at the Connecticut Agricultural Experiment Station, New Haven, Connecticut, under the direction of Mr. Neely Turner, Chief Entomologist of the Station. While there, Mr. Wheatley gave a Lockwood Lecture on 'Insecticidal Dusts.' He also visited research institutes in the Northern, Mid-Western and Eastern States, and attended an Eastern Branch Meeting of the Entomological Society of America in New York, and a Vegetable Conference in Springfield, Massachusetts. The visit was most profitable to Mr. Wheatley and to this Station, and appreciation is expressed to the W. K. Kellogg Foundation for providing the Fellowship, and to the Agricultural Research Council for providing the voyage expenses to and from New York. Thanks are given to the Director of the Connecticut

Experiment Station and to Mr. Neely Turner and his staff for all they did to make Mr. Wheatley's visit so successful and pleasant. Thanks are also due to members of the staffs of the research institutes who gave of their time to show Mr. Wheatley their work and discuss problems with him.

Mr. L. E. Watts was enabled by means of a grant kindly provided by the A.R.C. to visit Wageningen in Holland and Verrieres in France in 1954, where he inspected lettuce variety trials and had discussions on synonyms with the workers concerned. A worker from each place, together with one from Western Germany, then inspected the lettuce variety trials at Wellesbourne. As a result of these inspections and discussions it is hoped to produce an international paper on lettuce synonymy.

In July Miss D. E. Fisher spent five days in Jersey where she examined the *Didymella* disease of tomatoes in the field, and saw and discussed the *Didymella* work of the mycologist Dr. T. Small and his assistant Mr. D. H. Phillips, who are thanked for their kind co-operation.

The scientific and administrative staff had a Christmas lunch in the temporary canteen on 18th December, 1953, when 33 people had a most enjoyable meal followed by singing of Christmas carols. On 15th January, 1954, the third Christmas—New Year party was held in the Concert Hall, Wellesbourne, where the staff and their friends, 65 in all, had a very happy evening. Thanks are due to the Sports and Social Committee who organised the party, to wives of staff who helped with the catering, and to members of the staff whose talent in the sphere of entertainment added much to the enjoyment of the company.

The Sports and Social Committee consisted of Miss Fisher, Miss Thorpe, Mr. Bridgewater (Chairman), Dr. Haigh (Treasurer), Dr. Tomlinson (Secretary) and Mr. Wheatley—with Dr. Haworth taking his place while he was in the U.S.A. Four sub-committees were formed during the year to deal with cricket, hockey, netball and tennis, and donations of sports equipment were made by several of the staff. The cricketers had a good first season in that they won nine, lost five and drew two matches with local clubs. The hockey players put in a fair amount of practice but only a few matches could be arranged. During lunch time, table tennis and netball were played. The two grass tennis courts were ready for play during the summer but the wet weather restricted their use. Another court was sown with grass in 1954.

RESEARCH

Plant Breeding

Large numbers of British and foreign varieties of lettuce and red beet have been in trials for three years, and varieties of spring cabbage for two years. With few exceptions, the 246 lettuce varieties had a high standard of purity but some had a poor performance. The number of synonyms was high; there were probably only 28 distinct varietal types among 136 British varieties. Crosses have been made using varieties which appeared to have some resistance to Tip burn and others which gave indications of being slower in bolting than usual. The standard of purity in 245 varieties of red beet was also quite high. Much variation in leaf shape occurred, however, in varieties of the Covent Garden type, and to a moderate extent in the Globe type with Egyptian leaves. In red beet also there was a high proportion of synonyms as judged from morphological characters. Varieties differed in proneness to bolting and in the appearance of the rings in the root. Intervarietal crosses have been made. 138 varieties of spring cabbage have been in trials and, as in red beet, there was often considerable variation within varieties. Most of the 48 foreign varieties bolted without hearting and the work so far has reduced the 90 British varieties to 23 distinct types. Similar work has been started with 114 varieties of forcing radish.

A trial showed that a crop grown from naturally produced hybrid seed between Brussels sprouts, Cambridge Special and Cambridge No. 3 was no better than that of the higher yielding parent variety. There was evidence of hybrid vigour but it appeared that interplanting of the parent varieties did not produce a preponderance of hybrid seed. Experiments were continued with different systems of breeding and with different techniques in breeding Brussels sprouts. In the course of this work male

sterile plants were found and if this character is inherited it might prove to be valuable in future breeding work. Some data, though not yet complete, were obtained on the amount of natural crossing between brassicas which occurs at different isolation distances on the Station.

The progeny of an artificially created tetraploid plant of asparagus, which was also a hermaphrodite, appeared to have fewer but bigger spears than normal diploid varieties. The next generation has now been established and it is hoped that from among these plants the combination of large spear and high spear number will be found.

Breeding and selection work was continued with Drumhead cabbage, red cabbage, early cauliflower, winter cauliflower, Brussels sprouts and onions. Onion plants were found which were functionally male sterile and if this proves to be a heritable character it should be useful for the production of hybrid varieties. As usual, nucleus stock seed of those Cambridge varieties which are on the market was produced for further multiplication by the N.I.A.B. Nucleus stock seed of promising new varieties was also produced for use by the N.I.A.B. in variety trials.

Chemistry

Three important long-term field experiments with vegetables were started in 1954, on soil which had been used in the past for ordinary farm crops. Soil samples were taken from all the experimental plots before the different treatments were given and the crops grown. These samples will be examined in detail in due course.

One experiment is designed to provide information on the effect of different depths of ploughing, of rotavating, and of incorporating fertilisers at different depths (with and without farmyard manure), on the yield and quality of vegetables grown in the three-year rotation of early peas, spring cabbage, leeks and Brussels sprouts; and also on the effect of these treatments and croppings on the soil.

Another experiment is laid down to compare organic and inorganic manures as sources of nitrogen for vegetable crops. Hoof and horn meal, and nitrochalk are being applied in various ways and quantities (with and without farmyard manure) in a three-year rotation of early potatoes, spring cabbage, leeks and carrots. Here again, the effects of these treatments and croppings on the yield and quality of the crops and on the soil, will be studied.

Information of a fundamental nature concerning the nutrient requirements of vegetables is to be obtained from another experiment. The treatments consist of three rates of application of each of the main nutrients, nitrogen, phosphorus and potassium combined in all possible ways, with and without farmyard manure, making a total of 54 different treatments. The three-year crop rotation is early potatoes, spring cabbage, red beet and carrots.

These extensive experiments were brought through their first year satisfactorily despite the difficulties usually met in bringing a ley into vegetable production and despite the exceptional weed problems experienced during the wet summer of 1954.

The field experiments where different dosages of the soil conditioners 'Krilium' and 'Merloam' had been incorporated in the soil, were continued in 1954. This was the third year of a two-year rotation of peas, spring onions, lettuce and white turnips with 'Krilium', and the second year of the rotation with 'Merloam'. The effects of these soil conditioners on the crops, as in 1953, were disappointing and the experiment is not being continued.

Irrigation

Progress was made in devising new techniques and in improving existing ones for carrying out irrigation experiments using different regimes. These techniques concerned the control of irrigation treatments and the assessment of results. The experiments carried out so far have been of the small scale type and the experience thus gained will enable larger scale experiments, approaching more closely to normal irrigation practice, to be started in 1955.

A regime is a system of watering which is governed by the current moisture conditions of the soil, i.e. a given depth of soil is restored, by watering, to field capacity whenever its moisture content falls to a given value. A wet regime is one where the soil moisture content is not allowed to become low, and hence water is applied often in small quantities. The reverse applies with a dry regime. The use of these regimes, which can be modified in various ways, provides definite systems of irrigation procedure which can be repeated with some accuracy in order to give comparable results.

The experiments of 1954, where the crops were protected from rain, showed that with turnips the best germination and establishment of the crop was obtained with a wet regime involving the total application of 2.6 inches of water as a minimum. The wet regimes, up to a total of 5 inches of water, also gave the highest yield of roots and of tops but the flavour was reduced. With lettuce, like turnips, the best germination and establishment was produced with a wet regime but, with peas, this was achieved with a drier regime. Lettuce grown under a wet regime, a total of 4.2 inches, was slightly earlier in maturing, and had more disease than under drier regimes. After the crop was established, a dry regime gave the highest yield of marketable plants. Irrigation affected the taste and texture of lettuce.

Entomology

At Wellesbourne and other places cabbage root fly did much less damage to summer cauliflowers in 1954 than in some years, but it caused heavy damage in the north of England and in Scotland. At the N.A.A.S. Experimental Horticulture Station at Stockbridge House the attack was severe and insecticidal treatments increased the yield by 470 per cent. Studies of the phytotoxic effect of cabbage root fly insecticides were made during 1954. Double the recommended concentrations of gamma BHC suspension, i.e. 2×0.2 per cent., applied as a liquid spot treatment, caused stunting of summer cauliflowers whereas double concentration of aldrin did not injure the plants. Brassica plants were also dipped in insecticidal solutions at transplanting. Gamma BHC and aldrin both gave satisfactory control by this method but at a concentration of 0.5 per cent. gamma BHC was highly phytotoxic whereas aldrin was not phytotoxic. Conditions for transplanting were excellent, however, and with warmer and drier weather at transplanting phytotoxic effects might have occurred at lower concentrations of the insecticides.

The effectiveness of the insecticides aldrin, dieldrin and gamma BHC for the control of carrot fly has been compared, when they were applied as dressings to carrot seed. Aldrin was the least effective and gave poor control. Dieldrin was less effective than gamma BHC on the highly organic fen soils in East Anglia but at Wellesbourne it gave good control, equal to that of gamma BHC. Both insecticides were applied at the dosage of 2 ounces of 50 per cent. insecticide per pound of seed. The important feature about the dieldrin treatment, however, was that it caused no tainting of the carrots, whereas tainting may occur following the use of gamma BHC as a seed dressing. If these results are confirmed in further field experiments, it would appear that seed dressings with dieldrin should be preferred to those with gamma BHC for carrots grown on light or medium loam soils, especially where the carrot fly infestation is unlikely to be severe.

Carrot fly also attacks parsley and in recent years it has caused severe losses in Scotland. An experiment was carried out there and it was found that a dressing of $1\frac{1}{2}$ ounces of 50 per cent. gamma BHC per pound of seed gave excellent control of the pest.

It is well known that parsnips are also attacked by carrot fly and the Pathology Section, as a prerequisite to its studies on parsnip canker, has succeeded in preventing fly damage by the liberal use of insecticide. This particular method, however, is not an economic proposition and no practicable control measure is known. Studies have been made, therefore, of the biology and habits of the fly and its larvae which attack parsnips, as a preliminary to dealing with the problem of developing an economic method of control.

Observations were made again in 1954 on pea aphid populations on lucerne

and peas, and upon how they were affected by predators and parasites. Preliminary observations were also begun on the biology and incidence of the lettuce root aphid.

Information on the time of emergence of the pea moth in the field is valuable if the pea moth is to be controlled by spraying pea crops with DDT emulsion. Efforts have been made to develop a method, based on soil temperatures, for the prediction of the beginning of emergence but although good progress was made, some discrepant results were obtained. It has now been established, however, that pea moth larvae from different districts differed in their temperature requirements and hence differed in the time of emergence. When the temperature characteristics of larvae from a particular source were determined, the time of emergence was predicted fairly accurately. Studies were also carried out on the correlation between temperatures of bare soil and of soil covered by a crop, and the time of emergence of pea moth adults.

Pathology

Investigations on the crook root disease of watercress have been continued. Work is in progress with the object of determining why, in general, the nearer plants are to the source of water entering the bed the better is their vigour and the less is the amount of crook root infection. The addition of iron and of phosphate to water did not suppress crook root infection either in the laboratory or in the commercial beds. Some evidence has indicated, however, that the calcium bicarbonate content of water had some connection with the degree of crook root infection and this is being investigated further. Surveys during the summer of 1954 showed that virus-like symptoms were widespread in commercial beds. Experiments have indicated that this is a virus disease and further work will be done to identify the virus or viruses and to measure the disease effect on crop growth and yield.

Investigations were continued on the silvering disease of red beet which has severe effects on seed crops of the variety Cheltenham Green Top. It has been found that the disease is caused by a bacterium and that it is seed-borne. Work has been done and is still in progress on devising a method of eliminating seed-borne infection, and on determining how the disease is spread in the field so that steps may be taken to control it.

Further work was done with the object of preventing the entry and of controlling the spread of *Didymella* stem rot disease in outdoor tomatoes. It was shown that the disease could be introduced through infected seed, soil and canes, and that infected canes could be decontaminated by formalin treatment. Work has been done also on heat treatment of seed containing the fungus, and on testing for resistant varieties and species.

Studies were started on rhubarb plants which showed virus-like symptoms and it has been found that at least two distinct viruses occur. Attempts will now be made to measure the extent to which plant vigour is reduced by infection with these viruses.

An insecticidal treatment was found which controlled attacks of carrot fly on parsnips and in consequence parsnip canker can now be studied without the complication of carrot fly damage. Preliminary experiments were also carried out using heat treatment of cuttings for the control of rust in field crops of mint.

Weed Investigations

Work was begun on the study of annual weeds as affected by different manurial and cultural treatments used in a rotation of different vegetable crops grown on what has been corn land. These are long-term experiments but it is hoped that the results will ultimately lead to improvements in certain cultural weed control methods. The first results indicate that before the experiments were begun there was a very high population of viable weed seeds in the soil, not less than 180 million per acre. Studies on the behaviour of seeds of important annual weeds of vegetable crops and on the life cycle of these weeds have been continued.

The promising results obtained previously with pentachlorophenol in oil/water emulsion for pre-emergence weed control in onions and lettuce have been substantiated. This herbicide, if used correctly, appears to be both safe regarding the

crop and effective against annual weeds. Tests of this technique will now be carried out on a wider scale.

The encouraging results obtained with CMU, 3-(p-chlorophenyl)-1, 1-dimethylurea, as a pre-emergence herbicide were not confirmed under the conditions of high rainfall which occurred during the 1954 growing season. Although the effects on weed species agreed closely with those previously observed, greater damage to crops was caused, and this chemical is clearly not selective enough in wet seasons on light land. In would therefore be too risky for use on annual vegetable crops in a variable climate such as ours. Our initial tests with CMU for control of some weeds in established beds of asparagus, however, have been promising.

Vegetable Washing

The member of our staff who was seconded to the Ditton Laboratory of the D.S.I.R. continued during the year the joint investigations on the present methods of commercial washing of vegetables and their effects on the keeping qualities of the washed products. The output of work was reduced owing to illness but work was done on carrots, celery, radishes, red beet and runner beans. The D.S.I.R. hopes to produce a report in the near future in which the results of these investigations will be given. With bunched carrots, for example, which were washed by machines, the results indicated that the carrots benefited from washing in that wilting of leaves and roots was delayed as compared with the unwashed carrots. On the other hand, there was more rotting of the leaves and roots of the washed carrots than of the unwashed carrots but the rotting of the roots was not extensive or serious. Both wilting and rotting were reduced by storing at 55°F. as compared with 65°F. Washing of the carrots had clearly increased the damage both to leaves and roots.

Statistics

The Statistics Section has again given advice and assistance to the research staff on the design of experiments and analysis of experimental results. This service has been given also to the N.A.A.S. Experimental Horticulture Stations and other bodies.

Investigations have been carried out on spacing experiments and on the efficiency of field experiments in general, with vegetables. Comparisons have been made of different methods of sowing, rearing of seedlings, etc., and their effects on the accuracy of an experimental result in relation to cost. This work is still in its early stages but holds out promise of providing valuable information. Thus, for example, the results indicate that a small proportion of missing plants in an experiment with spaced row-crop vegetables badly affects the accuracy of the results, and that in certain cases hand-sowing might prove to be cheaper in the long run than machine sowing for some experimental work.

Further work was carried out on the genetics of continuous variation in French beans and on statistical problems connected with the subject.

The close relationships between the Station and the N.A.A.S. Experimental Horticulture Stations have been maintained. The Director has continued to serve on the Advisory Committees of these Stations, and to act as Chairman of the Vegetable Working Party which co-ordinates the experimental work with vegetables on the Stations. Field experiments with vegetables, in extension of those done at Wellesbourne by the various sections, were carried out during the year at the Stations at Efford (Hampshire), Luddington (Warwickshire), Rosewarne (Cornwall), and Stockbridge House (Yorkshire). This collaboration is much appreciated.

In seed maintenance and multiplication work, and in the trials of varieties, the N.V.R.S. and the N.I.A.B. again co-operated; and the Director continued to serve on the Vegetable Trials Advisory Committee of the N.I.A.B.

FARM

The outstanding feature of the 1953-54 farming year was the weather. While the wet weather favoured the growth of vegetables and root crops and retarded the development of some pests, it created difficulties with wet ground and weeds and interrupted hay-making and harvesting.

At Wellesbourne about 200 tons of grass silage was made, and about 80 tons of hay was made and stored in the Dutch barn. The frequent rain gave an excellent establishment of a new ley in Big Cherry Ground, following vegetable cropping. The cereal crops were satisfactory and only the oats suffered from lodging. Vegetable crops grew well and were of good quality. Farm root crops gave a heavy yield and were clamped in good condition in spite of the rain. Blight attacked the potato haulms in July and August and, although they were treated with copper sprays, the haulms were killed early in September. It appears, however, that blight has not caused any excessive loss in the stored crop.

99 cattle were wintered in the yards and were fed entirely on food produced on the farm. They were grazed on the leys where there was a plentiful supply of grass and 62 were sold, fat, during the spring and summer of 1954. The policy of breeding our own pigs was adopted during the year under review, and four gilts and a boar of the Large White breed were bought from well known pedigree herds. Two gilts farrowed twice during 1954 and reared 40 pigs, and the other two gilts farrowed once and reared 22 pigs. 125 pigs were sold during the year, mainly for bacon. 600-700 tons of dung was produced for use in vegetable production.

Among items of equipment bought during the year were a wheeled diesel tractor, tipping trailer, dung spreader, reversible plough, potato-digger, potato-sorter and four pig-farrowing huts. A new 'station waggon' was purchased for the transport of staff and material in connection with work outside the Station thus allowing the old one to be used almost wholly for work on the farm.

Improvements made included the laying of tile drains in the north-east corner of Sheep Pens which functioned well during the latter part of the year. Concrete post and four-foot-high chain-link fencing was erected on three boundaries of Soakwaters, along the roadside and brookside of Big Ground and along the brookside of Long Meadow. This completes the chain-link fencing of a block of 165 acres where most of the field experiments are carried out. An ash road was laid along the western boundary of Soakwaters thus completing an internal road system for the 165 acre block. Three loose-boxes were converted into four pig pens capable of housing 60 pigs.

The Sub-Station at Paglesham was affected by the inclement weather to a greater extent than the Station at Wellesbourne. A drought during April and early May was followed by almost continuous wet weather, with little sunshine and high winds. Weed growth was luxuriant and control was almost impossible. A satisfactory crop of hay was obtained from part of the ley on O.S. 48. The cereal crops grew well but were badly lodged and hence the quality of the grain was affected. Harvesting was done with difficulty and involved a good deal of hand labour. The yields, however, appeared to be quite reasonable. Potatoes grew well but they were attacked early by blight and the haulms had to be burned off in August. This reduced the potential yield but a good yield was obtained nevertheless. The root crops did not respond well to the weather but provided enough to feed the livestock. 1954 was a bad year for the production of vegetable seed and our vegetable seed crops at Paglesham gave rather poor yields, with the exception of onions.

24 cattle were wintered in the yards and summer-grazed on the ley, O.S. 48, until they were sold, fat. They were replaced by a further lot of 30 cattle which obtained good grazing on this ley. Three Essex gilts were bought during the year. When they farrowed, two refused to feed their offspring and the third succeeded in rearing only four pigs. 37 pigs were fed and sold mainly for bacon during the year. A good supply of dung was produced in the stockyards for application to land devoted to vegetable seed crops. A wheeled diesel tractor and a number of implements were

purchased in the autumn of 1954 so that some of the farm work could be done other than on a contract system.

Visitors

The number of visitors to the Station during 1953-54 was 210. Among them were the following from overseas :—

<i>Australia :</i>	Mr. G. M. E. Morgan, University of Adelaide. Mr. K. Finlay, Department of Agriculture, Perth. Mr. L. F. Myers, C.S.I.R.O., Canberra. Mr. A. C. Orman, Department of Agriculture, Sydney.
<i>Canada :</i>	Mr. G. Knowles, Central Experimental Farm, Ottawa. Mr. Maurice F. Welsh, Dominion Laboratory of Plant Pathology, Summerland, B.C.
<i>Cyprus :</i>	Mr. Michael Papa Jacovou, Department of Agricultural, Famagusta.
<i>Denmark :</i>	Mr. Jörgen Jörgensen, Statens Plantepatologiske Forsøg, Lyngby.
<i>Egypt :</i>	Mr. Ahmed Mahrouki, Vegetable Research Section, Ministry of Agriculture, Dokki.
<i>Germany :</i>	Mr. Glaschke, Bundessortenamt für Nutzpflanzen, Bamberg.
<i>Holland :</i>	Mr. C. M. Rodenburg, Wageningen. Mr. J. Sneep, Wageningen.
<i>Israel :</i>	Mr. T. Weiss.
<i>Norway :</i>	Miss Marie Bragdø, Agricultural College of Norway. Dr. Oivind Haugen, Agricultural College, Vollebekk.
<i>New Zealand :</i>	Mr. T. A. M. Cruikshank, Crop Research Division, Christchurch. Mr. H. J. Chapman, University College, Auckland. Dr. E. E. Chamberlain, Plant Diseases Division, Auckland.
<i>N. Rhodesia :</i>	Mr. E. N. Cooling, Ndola.
<i>S. Africa :</i>	Mr. J. Hunt Holley, Pietermaritzburg. Mr. H. A. Kendall, Port Elizabeth.
<i>Trinidad :</i>	Mr. S. Rodrigues, Imperial College of Tropical Agriculture.
<i>Uganda :</i>	Mr. Q. A. Geering, Empire Cotton Growing Corporation, Namulonge. Mr. H. J. Faulworth, Empire Cotton Growing Corporation, Namulonge. Mr. Peter Huxley, Makerere College, Kampala.
<i>United States of America :</i>	Professor J. Carew, Cornell University, Ithaca, N.Y.

In addition the following 11 parties visited the Station :—

29th May	... Staff and students from the Botany Department, University of Birmingham.
p.m. 17th June	... Members of the Marton Young Farmers Club, Marton, near Rugby.
p.m. 28th June	... Members of the Long Itchington Young Farmers Club, Long Itchington, near Rugby.
29th June	... N.F.U. Vegetable Committee.
1st—2nd July	... Party from Holland and Germany.
5th July	... Staff and students from the School of Agriculture, University of Nottingham.
28th July	... N.F.U. Roots and Seeds Committee.
28th July	... Agricultural Research Officials from France.
29th July	... N.A.A.S. Horticultural Advisory Officers.
19th August	... Staff and students from the Botany Department, University of Birmingham.
17th September	... Members of the Association of Applied Biologists.

Acknowledgments

Acknowledgment is made to the Agricultural Land Commission for the assistance given in carrying out the farming work at Paglesham.

Special thanks are given to members of the staff who have carried out duties in addition to their normal work. Mr. Winter assisted in connection with the fittings and services in the new buildings and glasshouses, and Mr. Roberts continued to

supervise the library. The Canteen Committee dealt with the equipping of the new canteen in addition to the normal work of running it. The Committee consisted of Miss Beardall, Miss Forrester, Mr. Bridgewater (Chairman), Mr. Nelder (Secretary) and Mr. Wheatley (Treasurer) ; in the absence of Mr. Wheatley abroad, Mr. Nelder became Treasurer and Miss Forrester, Secretary. Mr. Nelder again assisted in the editing of this Annual Report.

Grateful acknowledgment is also made to all the staff and employees for the loyalty with which they have carried out their work.

Thanks are given to the Executive Committee and the Sub-Committees, and particularly to the Chairman of the Governing Body and the Chairman of the Committees for the assistance they have given.

Thanks are also due to all those friends of the Station, particularly growers and commercial firms, who have kindly donated books, seeds, plants and other material, and who have helped in many other ways.

J. PHILP,

25th February, 1955.

PLANT BREEDING REPORT

By J. C. HAIGH

Breeding Projects

The third trial of commercial varieties of cabbage lettuce and red beet, made during the year under review, completes the preliminary or exploratory stage of the breeding projects with these crops, and the data collected during the past three years will be used to plan the details of the breeding programmes now to be started. The second trial of varieties of spring cabbage was also carried out. The form of the trials here reported was the same as in previous years ; 232 varieties of cabbage lettuce, 245 of red beet and 95 of spring cabbage were sown in replicated, randomised blocks and data were collected on morphological, physiological and economic characters. The groups of identical or similar varieties, based on previous observations, were generally confirmed.

Work was started during the year on a similar project with forcing radish, and 114 commercial varieties have been grown.

Lettuce

Mr. Watts has studied 232 varieties of cabbage lettuce, those additional to the 1953 collection being new varieties appearing in seedsmen's catalogues. There were 81 Butterhead types, divisible into 30 groups, 54 White Boston types in 9 groups and 97 Curly types in 21 groups. The groups are variable in size, the larger ones being composed mainly of English varieties, while the smaller, often containing one variety only, are mainly of Continental or American origin. The inference is that while the same general types may be found in all lettuce-growing areas, more control is exercised abroad over the number of varieties of any one type. A more detailed account of the results of Mr. Watts' work over the past three years will be found later in this report.

During 1954 we have had the benefit of discussion on the nomenclature of lettuce varieties with workers in Holland, France, and Western Germany, who inspected the lettuce plots at Wellesbourne. Mr. Watts also inspected lettuce trials in Holland and France. As a result of this useful discussion it is hoped to issue shortly an international list of lettuce varieties grouped according to morphological and physiological similarities.

Red Beet

Mr. Holland has grown 245 varieties of red beet and has divided them into the same 8 major groups as were reported in 1954, with the exception of one Continental variety, Rouge Crapaudine, which does not fit into the classification. It is the only rough-skinned beet in the collection and has peculiar twisted light-green leaves stippled with purple. The remaining groups, like those of the lettuces, are variable in size and the single-variety groups are usually of continental origin. The Detroit group again heads the list with 88 varieties, and it is surely no coincidence that this group is the one most widely grown. The term synonymous cannot strictly be applied to the varieties in this (or other) groups, because of the highly-developed out-breeding mechanism of the beet, but the resemblances are so close as to leave no doubt of the common origin.

The second largest group, Non-Bleeding, has 30 varieties and is divisible into 5 sub-groups, one of which contains no English variety. Intermediates are next with 29 varieties and no sub-groups ; Egyptian globe, with 22 varieties in 6 sub-groups (again one of the sub-groups is not represented in this country) and Flat Egyptian with 20 varieties in 4 sub-groups, come next in order. The Cheltenham Green Top has 13 representatives with 4 sub-groups, and although these varieties are commonly held to germinate badly, their germination has been satisfactory in our trials. The

Dwarf Blacks have 12 varieties of which one, of continental origin, is different from the others. The last group, Covent Garden with 30 varieties, differs from all the others in having a reasonably-uniform root but great diversity of leaf type. There is as much variation in this character within varieties as between varieties.

It is hoped next year to publish a more detailed account of the classification of beet varieties.

Spring Cabbage

The second trial of spring cabbage varieties was planted in the autumn of 1953 and included 95 varieties. They were planted in two series; one spaced at 18×9 inches and put out at the beginning of September for greens, the other planted a fortnight later at 18×18 inches for development into hearted cabbage. The difference of a fortnight was critical; the earlier planting was almost ready for cutting when it was hit by the hard frost of February 1954, and when growth started again, almost every variety ran up to seed. The later planting did not suffer in the same way and gave quite a reasonable crop. Dr. Johnson has collected data on head characters, yield and reaction to *Botrytis* (of which there was a severe attack following the frost) and has distinguished 19 groups based on size and shape of head and period to maturity. The six largest groups together contain 54 varieties, among which are those most commonly grown in commerce. Two of the groups between them contain 8 varieties which are considered to be unsuitable for autumn sowing and four of these are foreign; the remaining 6 foreign varieties in the trial produced elliptical heads with a glossy appearance which would probably not find a ready market in this country. As with red beet, there is often considerable variation within a variety, and classification cannot be as exact as it is with lettuce. With a view to the collection of more precise quantitative data the third trial, planted in the autumn of 1954, is designed to be amenable to statistical analysis.

Forcing Radish

114 varieties of forcing radish were grown under Dutch lights and Mr. Watts has studied their vegetative characters. As a result, he has tentatively divided them into 12 groups on the basis of root shape and colour. The largest group has been called Scarlet Globe and includes 42 varieties with names such as Saxa, Dazzler, Crimson King, Ruby Gem, Ne Plus Ultra and Express. The next largest group resembles Scarlet Globe in shape, but the root, instead of being uniformly red, has a small white area at the base; this group includes the varieties Gaudry, Scarlet Gem, Victoria and Scarlet Perfection. The next three groups, French Breakfast, Long Red and Long White are of approximately the same size and these 5 groups contain more than half the total number of varieties. The remainder show a range of shapes between globe and intermediate, and also varying proportions of red and white colour.

In an attempt to identify varieties in the seedling stage, cotyledons were measured when the seedling was producing the first rough leaf and the length/breadth ratio was calculated. This character could not be used as a reliable guide, however, because the variation within groups was as great as that between groups.

Asparagus

In 1952 there was established a small bed of tetraploid asparagus which had been presented to the Station by Dr. Janaki Ammal. While working at the Royal Horticultural Society's Gardens at Wisley, she had produced tetraploid plants of the variety Conover's Colossal by treating seed with colchicine, and among the plants so produced was one hermaphrodite; the 37 plants now growing at Wellesbourne are the progeny of this hermaphrodite plant. They show a gradation of sex forms from the pure male to the pure female, if one can regard numbers of berries set as an expression of relative femaleness. In 1954 a trial cut was made over a period of 4 weeks and the spears from each plant were counted and weighed; with such small numbers no very definite conclusions could be drawn, but the general indication was that the tetraploid would

produce, on average, fewer but bigger spears than the diploid. At the same time, there was a degree of variation in the performance of individual plants which suggested that it may be possible to combine large spear with high spear number. Natural progenies from these plants have been established and are being studied for commercial and genetic characters.

Breeding Methods

The inbreeding programme with Brussels sprouts has been continued and extended. Dr. Johnson has grown and examined the selfed progenies of Cambridge Special (1). Measurements made on these plants are awaiting analysis but the data suggest that although the first inbred generations have generally the same numbers of leaves as the parent lines, the leaf area is about 20 per cent. smaller. Most inbred lines have produced bolters, some as many as 80 per cent. of plants raised; the variety Cambridge Special tends to produce about 5 per cent. bolters if sown early, and the inbreeding has magnified this tendency. Selected non-bolting plants will be used to produce the second generation of inbreds, from which it is hoped that the bolting tendency will have been eliminated. Male sterility has been found in some of the inbred lines, and its inheritance is being studied with a view to the possibility of using this character in the production of hybrid varieties.

A large number of crosses has been made between plants of the S_1 generation of Cambridge Special in order to determine the type of incompatibility mechanism which operates in Brussels sprouts.

Progenies of the X-ray treated material (1) are still under observation, but no evidence has been found that the incompatibility system was affected by the treatment. We are again indebted to Dr. Lewis of the John Innes Horticultural Institution for having irradiated plants of Cambridge No. 3 sprout. Inbreeding has also been started with selected plants of this variety.

The trial using seed from the plots of interplanted Brussels sprout varieties Cambridge Special and Cambridge No. 3 (1) has indicated that the interplanting of alternate rows of the two varieties is not a practicable method of producing hybrid seed on a commercial scale; it was estimated that there was no more than 50 per cent. of crossing in either direction. Measurements were made of a variety of characters—yield, height of plant, width of plant, number of leaves, leaf area, and length/breadth ratio of petiole—and though statistically-significant differences could be found between means of populations in some of the plant characters measured, it was not possible, even with varieties so distinct as those used, to distinguish with certainty between hybrid and parent types in individual plants. There was some evidence of hybrid vigour but the yield of marketable sprouts from 'hybrid' plots was not significantly greater than that of the better-yielding parent.

Surveys conducted by the N.I.A.B. in recent years (2) have shown that varieties of Brussels sprouts may deteriorate rapidly after only a few generations of seed multiplication so that the type and quality may become quite unrecognisable. Two projects have been designed to throw light on the causes of such deterioration. In the first, a nucleus seed stock of Cambridge No. 1 has been selected at two different levels, namely 1 per cent. and 5 per cent.; the selected plants will be seeded in isolation from one another and progenies from them will again be treated in different ways so as to maintain greater or less control over the selection of seed-bearers. In this way it is hoped to learn what effect the level of selection will have on the quality of subsequent generations. A similar experiment with Cambridge Special will be started in 1955. In the second project, not yet started, the effect on subsequent generations will be observed of the deliberate contamination by cross-pollination of one variety by another and similar variety. This experiment is intended to simulate the results which may be produced if two Brussels sprout seed crops are grown with insufficient isolation from one another; such cryptic contamination may be an important contributory factor in deterioration.

In the 1953 Report (1) p. 11, mention was made of an experiment designed to provide data on the isolation distance required between brassica crops to prevent

interpollination. Seed from the varieties of *Brassica oleracea* used in this experiment has been sown and counts are being made of the numbers and types of hybrid plants.

Experiments have been started to determine the environmental conditions necessary to stimulate or inhibit flowering in Brussels sprouts.

The production of clonal material forms a necessary part of the inbreeding programme, and while no difficulty is experienced with Brussels sprouts and cabbage, cauliflower and broccoli are not easy to propagate vegetatively. North (3) has described methods of propagating cauliflower by root and curd cuttings; he stresses the difficulty of striking root cuttings, and it is common experience that curd propagation is successful only in small degree. Mr. Watts has had considerable success in propagating cauliflower by stem cuttings. The stem of a mature plant is split into two or four longitudinal sections according to its diameter; the sections are cut into lengths of 2-2½ inches, the medulla is scraped away, the remainder is surface-sterilised, dipped into a rooting hormone and plunged into sterile silver sand so that 1½ inches of tissue are below the surface. A little bottom heat is given to maintain a temperature of 60-70°F. and under these conditions, new shoots are produced in about one month. The best results are obtained with the middle part of the stem, where 75 per cent. success has been recorded. Although each portion will have at least one leaf scar, the adventitious shoot is frequently produced on the inside of the stem portion and not in association with the scar.

Seed Production

Nucleus stock seed was produced of the varieties listed below :—

Varieties which have already been distributed

Brussels Sprouts	..	Cambridge No. 3
Early Cauliflower	..	Cambridge No. 5
Winter Cauliflower	..	Cambridge Hardy Late
Onion	..	Cambridge No. 2
		Cambridge No. 10

Varieties, trials of which are not yet completed

Cabbage	..	Cambridge Drumhead
Winter Cauliflower	..	Cambridge No. X13

Promising varieties not yet included in trials

Onion	..	Cambridge No. 28
		Cambridge No. 33

The seed of onion Nos. 2, 28 and 33, Cambridge Hardy Late cauliflower and cabbage were produced at Paglesham and the rest at Wellesbourne. Seed was also produced of breeding material of the following: hybrid Brussels sprouts, self fertile sprouts and 'sproutless' sprouts (for genetic investigation), 'rosette' cabbage (for investigation of the mode of inheritance of this character), onion seedling lines, and lettuce varieties.

Plants of the following varieties were grown for selection and the production of nucleus stock seed in 1955 :—

Brussels Sprouts	..	Cambridge No. 1
Cabbage	..	Cambridge February
Early Cauliflower	..	Cambridge No. 7
Winter Cauliflower	..	Cambridge Dwarf April
Onion	..	Cambridge No. 2
		Cambridge No. 10
		Cambridge No. 28
		Cambridge No. 33

The cabbage, winter cauliflower and No. 10 onion were grown at Paglesham and the rest at Wellesbourne. Plants were also grown for the maintenance of breeding material of carrots, peas, parsnips and Hamburg parsley. Plants were also grown from stock seed of the Cambridge varieties produced by the N.I.A.B. from nucleus stock seed supplied by the N.V.R.S. for comparison with plants from nucleus stock seed. Assistance was given to the staff of the N.I.A.B. in the inspection and roguing of such stock seed crops.

Work at Outside Centres

Plants were selected from the breeding material of Roscoff broccoli grown at Rosewarne E.H.S. in order to find a strain which would mature in February/March, but the selected heads were all killed by the severe weather of late February 1954. A further area was grown in 1954 from the same stock of seed, and more selections will be made in February 1955.

Miscellaneous

Experiments were continued on the use of bees for pollinating brassicas under nylon cages, and our thanks are again due to Dr. C. G. Butler of Rothamsted for the loan of nylon cages and hives of bees.

Male sterile plants have been found in a nucleus stock seed crop of Cambridge No. 10 onion. The male-sterile plants have an abundance of fertile pollen, but the anthers fail to dehisce; there is consequently no set of seed unless the anthers are first ruptured. The inheritance of the defect is being investigated. If this form of male sterility proves to be heritable, it can be used with advantage in the production of hybrid varieties.

REFERENCES

- (1) HAIGH, J. C. (1953). Plant breeding report. *Ann. Rep. Nat. Veg. Res. Stn.*, 1953, 10-13.
- (2) HORNE, F. R. (1953). The testing and maintenance of improved strains of vegetables. *Rep. 13th Int. Hort. Congr.*, 1952, 1051-9.
- (3) NORTH, C. (1953). Three methods for vegetative propagation of *Brassica oleracea*. *J. R. Hort. Soc.*, **78**, 106-11.

SYNONYMY IN LETTUCE VARIETIES

By L. E. WATTS

INTRODUCTION

The varieties of lettuce commonly grown in this country, the U.S.A., and the Continent are composed of numerous diverse types. In order to ascertain the extent of the diversity and to select desirable types for future breeding work, a collection of over 200 varieties of summer lettuce has been grown and studied at the N.V.R.S., Wellesbourne, during the years 1952 to 1954.

It is essential to have some idea of the number of synonyms in order to select parental types for a breeding programme, and since 'new' and 'improved' varieties are regularly offered in seedsmen's catalogues, it becomes necessary to group morphologically similar though nominally distinct types.

As many seed catalogues as possible from the larger firms have been studied and it is believed that all varieties offered for sale to the general public have been included. In the list of synonyms which appears later in this paper the names of the firms supplying the seed have been included so that any misconceptions about types can be avoided. Similarity of name, but dissimilarity of type does occur (see Dryweather in Classes A6 and A12, and Champion in Classes A1, A21 and C1) but this is the exception rather than the rule.

Since lettuce is normally self fertilised (although cross fertilisation does occasionally occur), all plants within any particular variety are homozygous in respect of major genes. Segregation will probably still be occurring if a cross has been made fairly recently, but by the time a new lettuce variety is released to the public, segregation has virtually ceased and the variety is almost completely uniform. In the collection of varieties studied, very few rogues or segregants have occurred; most of the varieties have been allowed to seed at Wellesbourne, and the progeny have again been completely uniform. The conclusions reached concerning synonymy in this paper are, therefore, unlikely to be altered by a study of further generations.

Varieties named in this paper include those which have been offered as novelties in 1953 catalogues. A number of Cos and Leaf types of lettuce has been studied but they represent only a small sample and are not described in this paper.

Methods used in classification

The most recent publications upon synonymy in lettuce are those of Morse (1), Brian (2) and Miguel (3), the first two being rather out-dated by the present wealth of varieties, while the last deals only with seedling characters of a very limited number of varieties.

Brian (2) describes the characters which are considered appropriate for classification and most of them are used in this publication. He deals, however, with all classes of lettuce including those grown out of doors and under glass during the winter. Miguel (3) also discusses the whole range of cultivated lettuce types, but since identification is carried out on seedling characters only markedly dissimilar varieties can be distinguished on this basis (e.g. Crisp types and Butterhead types). Observation of differences between very similar varieties is extremely difficult in the seedling stage and the most satisfactory period for identification is at the stage of market maturity. It is appreciated that a number of the varieties listed here as summer lettuce are also grown at other periods of the year, and this point is noted in the descriptions of the actual varieties.

Characters studied for classification

(a) Seed colour

Seed colour of all the varieties grown at Wellesbourne has been either white or black. Yellow seeded varieties do occur, but according to Thompson (4) these are comparatively unimportant. Morse (1) in a most comprehensive list describes only 19 yellow seeded varieties, these being reduced to only four types after synonyms have been taken into consideration. Durst (5) found that black behaved as a simple dominant to white when crosses were made to determine the inheritance of seed colour. Thompson, however, found that two factors were concerned, one for white seed coat and one for yellow. When these factors are combined in the hybrid, the seed coat is black, and in the F_2 generation there are nine black : three yellow : four white. All black- and white-seeded commercial varieties which have been studied at Wellesbourne are true breeding and are therefore homozygous for seed colour.

(b) Pigmentation and depth of "greenness" in leaves

Both of these characteristics form a graded series amongst lettuce varieties. The range is from complete lack of anthocyanin in some groups (e.g. Group A1) to complete suffusion in others (e.g. Group A30), the intermediate stages including those slightly tinged types (e.g. Group B8), spotted types (e.g. Group A24) and lightly, but almost completely suffused types (e.g. Group A28). Thompson (6) indicates that two complementary genes, C and T, are necessary for anthocyanin production. With the presence of these genes a multiple allelomorph series $Rr'r$ governs the type of leaf pigmentation, R and C loci being linked but having 36 per cent. recombination. Pigmented is dominant to non-pigmented.

The intensity of greenness varies greatly in summer lettuce and for the purposes of this classification only three grades are used, light, medium and dark green. Thompson confirms the work of Bremer (quoted by Brian), saying that dark green leaves behave as a simple dominant factor to yellow green.

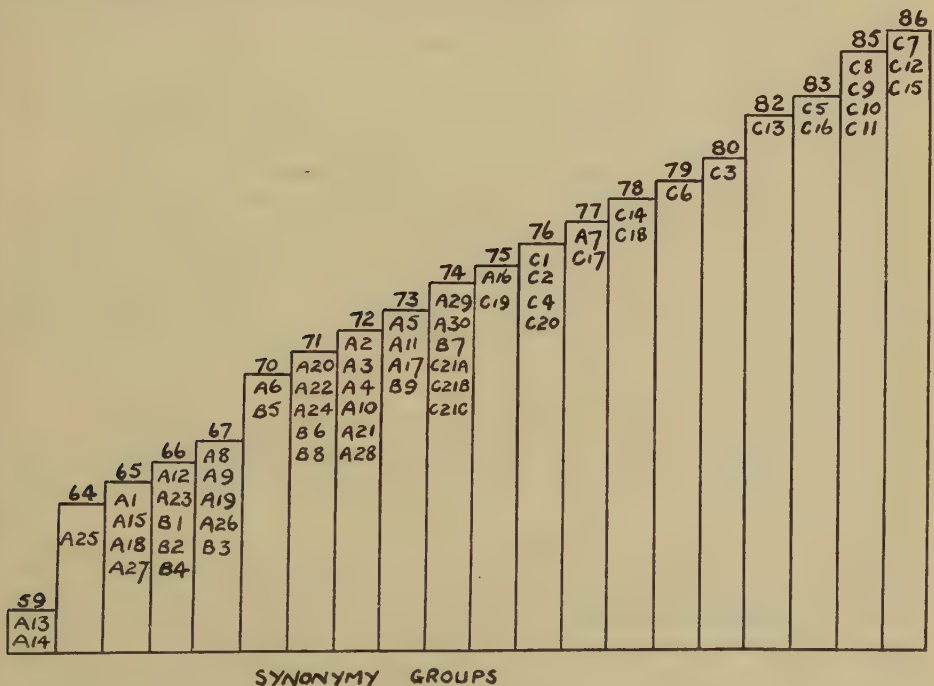


Fig. 1. Average periods from sowing to hearting. Synonymy groups within columns, period in days above.

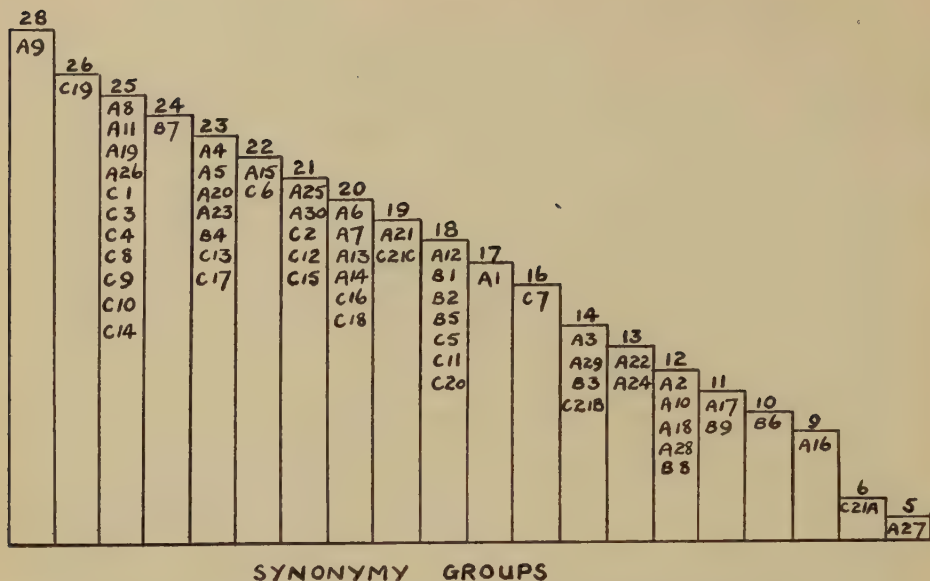


Fig. 2. Average periods from hearting to bolting. Synonymy groups within columns, period in days above.

(c) Leaf texture

Varieties of lettuce fall into two distinct groups based upon the texture of the leaves. The most commonly grown group in this country and on the Continent is that referred to as the Butterhead group, being composed of lettuce with leathery, rather 'greasy' leaves.

The second group of cabbage lettuce has leaves of a brittle or crisp texture, this crispness causing them to appear fresh over a longer period after cutting than the Butterheads.

Brian states that the crisp lettuces stand hot dry weather without 'bolting' much better than Butterheads, but results obtained at Wellesbourne do not support this statement. The Crisp varieties take considerably longer to mature than the majority of the Butterheads but the period from market maturity to bolting is very similar in both cases. Figs. 1 and 2 indicate the time in days from sowing to maturity, and from then until bolting respectively. The relative order of the varieties is probably correct over a wide range of conditions, but the actual numbers of days may vary in different environments.

(d) Further characters studied as an aid to classification

The characters already described are the most valuable for delimiting synonymous types, but other characters have been studied in order to help to confirm or deny the general conclusions.

The density of hairs or spines upon the abaxial side of the midrib and the shapes of mature leaves have been studied, but variation amongst plants within the same variety is common. These variations are quite large and synonymous varieties do not appear to possess a characteristic mean which will differentiate them from another group of synonyms. For the production of a workable classification with a minimum of effort there is no doubt that the most effective method is to study all varieties when they are just approaching or have reached market maturity. At this stage, owing to their almost complete homozygosity, each variety is extremely uniform, and recognition of even slight differences between varieties is comparatively straightforward.

Varieties have been studied up to their flowering and seeding stages in order to confirm conclusions made in the vegetative stage and the following list groups together those varieties which have appeared synonymous throughout their life history.

It is emphasised, however, that no yield trials have been carried out and the delimitation of groups is from observation only, but from judgment by eye it is considered unlikely that yield data between synonymous varieties would show any significant differences.

Synonymous groups

The 232 varieties have been divided into three major classes which are quite distinct. These classes are given headings according to the type most commonly represented and they consist of, A—All the Year Round, or Butterhead class, B—White Boston or Trocadero class and C—Webb's Wonderful or Curly Crisp class (plate 1). Each of these classes is composed of a number of groups of synonymous varieties and for easy reference by varietal name an index is included as an appendix.

Class A. All the Year Round or Butterhead types

Group A1—Black seed

Light to medium green. Very blistered. Heart soft but well packed—leaves not quite overlapping. Lower leaf surface considerably lighter than upper, thus causing heart to appear lighter than general colour. Few outer leaves, plants being mainly heart. Average diameter of whole plant 12 inches. Heart diameter 4-5 inches. (These measurements are typical at Wellesbourne in a normal season). This group is rather susceptible to downy mildew (*Bremia lactucae* Regel), lettuce mosaic, tipburn and *Botrytis cinerea* Fr. Average period from sowing to hearting, 65 days. Average period from hearting to bolting, 17 days. This group is sometimes used as an outdoor winter type but mainly in milder districts. It is also grown under Dutch lights.

<i>Synonyms.</i>	<i>Suppliers.</i>
Ace of Hearts No. 381	Ohlsens Enke (Denmark)
All the Year Round	Little & Ballantyne
All the Year Round Selected ..	Harrison (<i>Maidstone</i>)
Champion	Ryder
Covent Garden	Bunting
Criterion	Webb
Early Market	Little & Ballantyne
Early Market Allheart	Cooper Taber
Exhibition Cabbage	Dobbie
Fürchtenichts	Dippe (Germany)
Hjerter Es	Daehnfeldt (Denmark)
Market Giant	Yates
Matchless	Sutton
Selected All the Year Round ..	Bees
Wunder von Stuttgart	S. Müller (Switzerland)
Zwart Duitsch	Nunhem (Netherlands)

Group A2—White seed

Almost exactly similar to Group A1, but this group is white seeded and is slightly more glossy. Average period from sowing to hearting, 72 days. Average period from hearting to bolting, 12 days. Susceptible to downy mildew, *Botrytis* and mosaic.

<i>Synonyms.</i>	<i>Suppliers.</i>
Stubborn headed Yellow	Ohlsens Enke (Denmark)
Trotzkopf gelber	S. Müller (Switzerland)

Group A3—Black seed

Very similar to group A1 but rather larger and less compact. Not as blistered as former, but susceptible to the same diseases. Average period from sowing to hearting, 72 days. Average period from hearting to bolting, 14 days.

<i>Synonyms.</i>			<i>Suppliers.</i>
Cyrius oder Mogul	..	..	S. Müller (Switzerland)
Long Standing Trocadero	..	..	Harrison (<i>Maidstone</i>)
Stuttgarter Dauerkopf	..	..	S. Müller (Switzerland)
Stuttgarter Sommer	..	..	Dippe (Germany)

Group A4—White seed

Of similar size and habit to group A5 but of a pale green colour. Plants are rather loose with numerous outer leaves. Hearts of 5-6 inches average diameter and rather soft. It appears to be fairly resistant to *Botrytis*, tipburn and downy mildew. Average period from sowing to hearting, 72 days. Average period from hearting to bolting, 23 days.

			<i>Supplier.</i>
Grosse Blonde Paresseuse	..	..	Vilmorin (France)

Group A5—Black seed

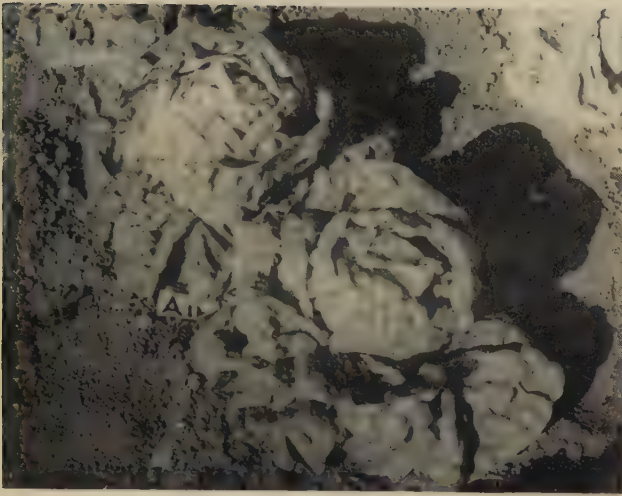
Similar in habit to group A1, but plants are dark green and are slightly larger. Heart is fairly small and there is a larger number of outer leaves. This group is the most susceptible to tipburn, but reaction to downy mildew, mosaic and *Botrytis* is similar to that of group A1. Average period from sowing to hearting, 73 days. Average period from hearting to bolting, 23 days.

<i>Synonyms.</i>			<i>Suppliers.</i>
Blonde du Cazard	..	..	Vilmorin (France)
Cazard	..	..	S. Müller (Switzerland)
Cazard No. 380	..	..	Ohlsens Enke (Denmark)
Cazard Elite Qual	..	..	S. Müller (Switzerland)
Distinction	..	..	Dickson & Robinson
Heidelburger Schloss	..	..	S. Müller (Switzerland)
Reine de juillet	..	..	Vilmorin (France)

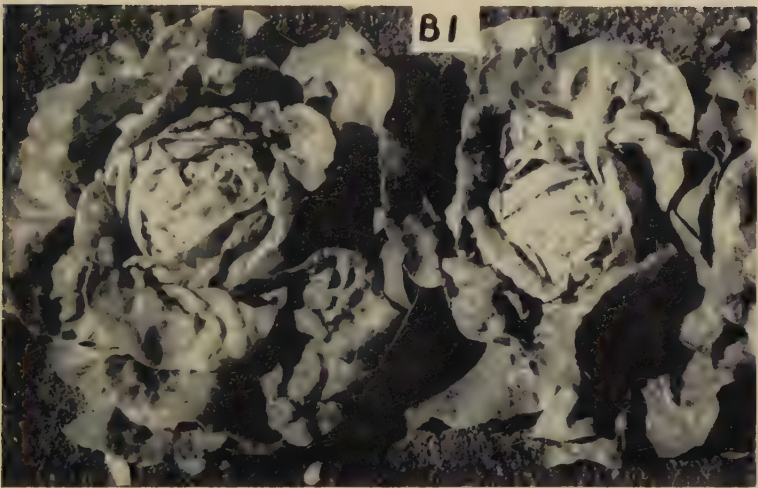
Group A6—White seed

Compact, fairly smooth-leaved, dark green plants, appearing rather more coarse than those groups described previously. Average diameter 12-13 inches. Hearts quite large compared with the size of the plants, being rather flattened with densely packed, rather exposed erect leaves. Heart is very solid. This group is fairly tolerant of the above diseases and appears to be slightly resistant to tipburn. This is a popular variety for growing in Dutch lights through the winter, but under these conditions is rather susceptible to downy mildew. Average period from sowing to hearting, 70 days. Average period from hearting to bolting, 20 days.

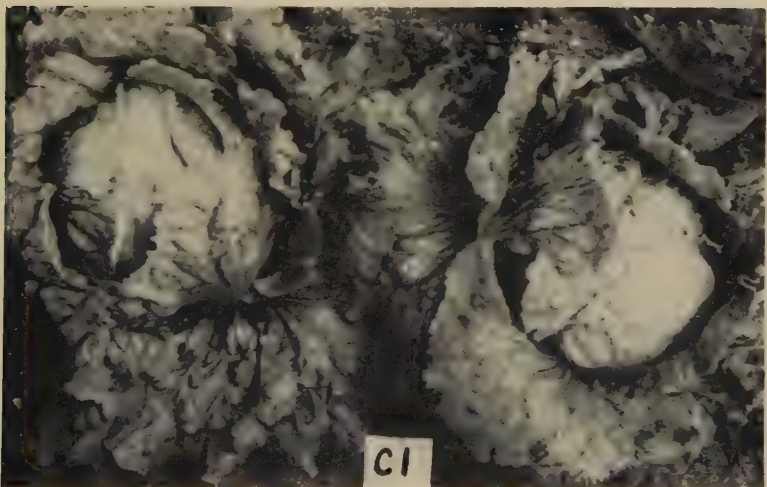
<i>Synonyms.</i>			<i>Suppliers.</i>
Dryweather	..	..	D. T. Brown
Evesham Market	..	..	Speed
Feltham King	..	..	Hurst
Feltham Wonder	..	..	Sluis (Netherlands)
Gloire de Nantes	..	..	Vilmorin (France)
Lord Kitchenier	..	..	Dickson & Robinson
Monument	..	..	Dickson (<i>Hawlmork</i>)
Pioneer	..	..	Dickson (<i>Hawlmork</i>)
Rufford Triumph	..	..	Clucas
Spring Beauty	..	..	Sutton
Syston Gloria	..	..	Harrison (<i>Leicester</i>)



Group A1. All the Year Round type.



Group B1. White Boston type.



Group C1. Curly Crisp type.

Group A7—White seed

Very similar to group A6, but heart is rather lighter in colour and is more rounded. The outer leaves are upstanding and incurved, the whole forming a very attractive lettuce. Rather susceptible to downy mildew but the reaction to other diseases is similar to group A6. Average period from sowing to hearting, 77 days. Average period from hearting to bolting, 20 days.

Supplier.

Market King Pennel

Group A8—White seed

Intermediate between groups A1 and A6. Colour is dark green, the plants being less blistered than group A1. Hearts smaller than group A1 but are quite solid. General habit is rather more erect. Plant diameter approximately 10 inches, heart diameter approximately 3-4 inches. Rather susceptible to *Botrytis*, downy mildew and tipburn. Average period from sowing to hearting, 67 days. Average period from hearting to bolting, 25 days.

Supplier.

Blonde d'été Vilmorin (France)

Group A9—White seed

Almost exactly similar to group A19 in size and habit (although there are few blisters and fewer outer leaves), but is quite yellow. Hearts solid with well overlapping leaves. Sizes as for group A19. Rather susceptible to downy mildew. Average period from sowing to hearting, 67 days. Average period from hearting to bolting, 28 days.

Supplier.

Rüdiger S. Müller (Switzerland)

Group A10—Black seed

Rather similar to group A6, but pale green with a few more blisters. Heart rounded and quite firm, but there are rather a lot of outer leaves in these plants. Susceptible to tipburn, downy mildew and *Botrytis*. Average period from sowing to hearting, 72 days. Average period from hearting to bolting, 12 days.

Supplier.

Summer Market Watkins & Simpson

Group A11—White seed

Medium to dark green with moderately blistered reflexed leaves. Heart rather flattened but very solid, the outer heart leaves being strongly reflexed at edges. Outer leaves of plant lie very flat upon ground. Plant diameter 11-12 inches. Heart diameter 3-5 inches. Very susceptible to downy mildew and *Botrytis*, but less susceptible to tipburn. Average period from sowing to hearting, 73 days. Average period from hearting to bolting, 25 days.

Synonyms.

Suppliers.

Chavigny	Hurst
Summer Giant	Toogood
White Favourite 	Barr

Group A12—Black seed

Rather similar in habit to group A19, but plants are medium green and larger (diameter 15-16 inches). Plants are slightly blistered and reflexed. Heart is rounded and very firm, diameter 5 inches, being very well covered. The outer leaves of the plant are semi-erect and are raised off the ground. These outer leaves become diseased very rapidly, however, and the group is susceptible to *Botrytis*, downy mildew

and tipburn. The plants appear very tender and appetising at market maturity. Average period from sowing to hearting, 66 days. Average period from hearting to bolting, 18 days.

<i>Synonyms.</i>				<i>Suppliers.</i>
Dryweather	..	..	..	Bunting
Market Wonder	..	..	..	Cooper Taber
New Queen	..	..	..	Fogwill
Resistent	..	..	..	Sluis (Netherlands)

Group A13—Black seed

Medium dark green plants with a very solid heart composed of vertically 'folded' leaves. Plants have very crinkly leaves, but are almost all heart. Diameter of whole plant 6-7 inches. This group consists of very small lettuce plants which are mainly popular in private gardens. Very susceptible to downy mildew but fairly resistant to tipburn. Average period from sowing to hearting, 59 days. Average period from hearting to bolting, 20 days.

<i>Synonyms.</i>				<i>Suppliers.</i>
Early Exquisite	..	..	..	Ryder
Langport Gem	..	..	..	Sharpe
Tom Thumb Selected	..	..	..	Toogood
Tom Thumb	..	..	..	Hurst
Wheeler's Tom Thumb	..	..	..	Daehnfeldt (Denmark)

Group A14—Black seed

This group is identical with group A13 in every respect except that the plants are slightly larger.

				<i>Supplier.</i>
Commodore Nutt	..	..	..	Toogood

Group A15—Black seed

Very dark green plants of similar form to groups A13 and A14 but with a much greater degree of wrinkling. This gives the heart a very distorted appearance, but it is large for the size of the plants. Plants are very susceptible to downy mildew, but fairly resistant to tipburn. Average period from sowing to hearting, 65 days. Average period from hearting to bolting, 22 days.

				<i>Supplier.</i>
Green Mignonette	..	..	..	Ferry Morse (U.S.A.)

Group A16—Black seed

A larger and looser form of group A13. The plants are taller and more erect with a greater number of outer leaves, the heart being small but well covered. It is softer than those in group A13, however. Diameter of plants 10 inches. Heart diameter 3 inches. This variety is a successful type for cultivation under Dutch lights. Very susceptible to downy mildew and tipburn. Average period from sowing to hearting, 75 days. Average period from hearting to bolting, 9 days.

				<i>Supplier.</i>
Gotte lente à monter	..	..	..	Vilmorin (France)

Group A17—Black seed

Large yellow form of group A1, but hearts are very poor, loose and contorted with little overlapping. Plants are quite erect with whorls of outer leaves. The heart is almost indistinguishable as such, and is about 2-3 inches in diameter. Diameter of whole plant is approximately 12 inches. Very susceptible to downy mildew and tipburn. Average period from sowing to hearting, 73 days. Average period from hearting to bolting, 11 days.

<i>Synonyms.</i>				<i>Suppliers.</i>
Berliner Gul	..	..	..	Daehnfeldt (Denmark)
Berlin	..	..	..	Ohlsens Enke (Denmark)

Group A18—White seed

A small form of group A17 of same ground colour with small but quite firm hearts. Very blistered but quite compact plants. Susceptible to *Botrytis*, downy mildew and tipburn. Average period from sowing to hearting, 65 days. Average period from hearting to bolting, 10-13 days.

Synonyms.

Stenhoved Guldgul	..	..
Stonehead Golden Yellow	..	..
Stonehead Yellow	..	..

Suppliers.

Daehnfeldt (Denmark)
Ohlsens Enke (Denmark)
Ohlsens Enke (Denmark)

Group A19—White seed

Silvery medium green plants with a 'floppy' appearance, this characteristic being due to reflexing of the outer leaves. Blistering is slight. The lower leaf surface is silvery, giving the hearts a much lighter appearance. Hearts are large (diameter 4-5 inches) and solid with good leaf overlapping, while the outer leaves are held fairly well off the ground. Diameter of plants 12-13 inches. This is an attractive looking variety, but it is possibly too light in colour or too yellow to be popular in the United Kingdom. Very susceptible to *Botrytis* and downy mildew. Average period from sowing to hearting, 67 days. Average period from hearting to bolting, 25 days.

Supplier.

Bautzener dauerkopf	..	..	Dippe (Germany)
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Group A20—White seed

Rather like a large form of group A19 but the colour is medium green with slight red tingeing and spotting. Plants are large (diameter 12-14 inches) with large hearts (diameter 4-5 inches) which are fairly solid and well covered. There are 4-5 outer leaves which just rest on the ground, so that the heart appears to have a 'frame' behind it. The plants look rather coarse and the shade of green is rather unappetising. Very susceptible to *Botrytis* and downy mildew. Average period from sowing to hearting, 71 days. Average period from hearting to bolting, 23 days.

Supplier.

Monstrueuse ronde d'été	..	Vilmorin (France)
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Group A21—White seed

Silvery medium green plants, with heart leaves and edges of outer leaves tinged red. Hearts (diameter 4-4½ inches) are rather conical and fairly firm, being well covered. Blistering is slight and there is a fairly high proportion of outer leaves. Diameter of whole plant 12-14 inches. Susceptible to downy mildew and *Botrytis*. Average period from sowing to hearting, 72 days. Average period from hearting to bolting, 19 days.

Synonyms.

Champion	..	..
Du bon Jardinier	..	..

Suppliers.

Bunting
Vilmorin (France)

Group A22—Black seed

Rather similar to group A12 in habit but leaves are more blistered and less reflexed. Colour is medium green with red spotting and tingeing. There is a large number of semi-erect outer leaves, but the hearts are quite solid, well covered and about 4 inches in diameter. Diameter of whole plant is 14-15 inches but it looks rather unappetising. Very susceptible to downy mildew. Average period from sowing to hearting, 71 days. Average period from hearting to bolting, 13 days.

Supplier.

Grosse Brune Paresseuse	..	Vilmorin (France)
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Group A23—White seed

Rather similar to group A1 but slightly darker green, less blistered and with a very squat heart which is large for the size of the plant. Leaves are red tinged and spotted. Diameter of plant 11-12 inches, diameter of heart 5 inches. Susceptible to downy mildew. Average period from sowing to hearting, 66 days. Average period from hearting to bolting, 23 days.

Supplier.

Bonte Chili Sluis en Groot (Netherlands)

Group A24—Black seed

Almost identical with group A22 but slightly smaller with more compact heart and glossy leaves. The inner leaves are red tinged or mottled, the outer leaves having a few reddish spots. Heart is rather flattened but firm. Very susceptible to downy mildew, mosaic and tipburn. Average period from sowing to hearting, 71 days. Average period from hearting to bolting, 13 days.

Supplier.

California Cream Butter .. Asgrow (U.S.A.)

Group A25—Black seed

A very bronzed version of group A15. The shade of green colour, where it appears, is rather dark and the anthocyanin pigment is more pronounced on the upper surface of the leaves. Plants are fairly small but have very wrinkled leaves, the heart leaves being erect but giving a distorted appearance. Susceptible to downy mildew. Average period from sowing to hearting, 64 days. Average period from hearting to bolting, 21 days.

Supplier.

Mignonette Asgrow (U.S.A.)

Group A26—Black seed

Small very dark green plants with red tingeing along the leaf edges, about equal in size to group A13. Leaves are smooth and very erect; the heart appears rather loose but is actually quite solid. The whole plant is extremely compact and there are few wasted outer leaves. The plants appear rather coarse and are very susceptible to downy mildew. Average period from sowing to hearting, 67 days. Average period from hearting to bolting, 25 days.

Supplier.

Brant Vineland, Ont. (Canada)

Group A27—Black seed

Very dark green plants with a light red tinge on leaf edges and a small amount of spotting, similar in size to group A26. Heart is small, round and fairly firm, there being no blistering of leaves. Very susceptible to downy mildew. Grown in the U.S.A. under glass. Average period from sowing to hearting, 65 days. Average period from hearting to bolting, 5 days.

Supplier.

Bibb Ferry Morse (U.S.A.)

Group A28—White seed

Brown/green butterhead with neither colour predominating, the raised blisters and an area of one inch around the leaf edges showing most brown colouration. Habit is rather similar to group A1 but plants are not as compact, the heart (diameter 4-4½ inches) being fairly soft. Diameter of whole plant is 12-14 inches. There is a large amount of blistering, the leaves being fairly erect, with the outer ones lying on the ground. Very susceptible to *Botrytis*, downy mildew and tipburn. Average

period from sowing to hearting, 72 days. Average period from hearting to bolting, 12 days.

<i>Synonyms.</i>			<i>Suppliers.</i>
Brauner Troztkopf	..	..	Dippe (Germany)
Stubborn headed Brown	..	..	Ohlsens Enke (Denmark)
Troztkopf Brauner	..	..	S. Müller (Switzerland)

Group A29—Black seed

Similar to group A28 but less erect, leaves more spreading and with a smaller though fairly firm heart (diameter 3 inches). Plants are considerably larger than the former group, being 16-17 inches in diameter and they contain much more pigment, which is of a reddish colour. The heart leaves are light green with only slight tingeing. Very susceptible to *Botrytis*, tipburn and downy mildew. Average period from sowing to hearting, 74 days. Average period from hearting to bolting, 14 days.

			<i>Supplier.</i>
Merveille des Quatre Saisons	..		Vilmorin (France)

Group A30—Black seed

A small (diameter 9-10 inches) very compact plant, deeply bronzed and with little trace of green even on the lower surface of the leaves. Heart diameter 3-4 inches, rounded, fairly firm and fairly well-covered. Plants fairly blistered with a few outer leaves which are clear of ground. Seems to stand hot weather better than group A1 which is its nearest apparent relative among the green types. Very susceptible to *Botrytis*, downy mildew and tipburn. Average period from sowing to hearting, 74 days. Average period from hearting to bolting, 21 days.

<i>Synonyms.</i>			<i>Suppliers.</i>
Bronze Beauty	..	..	C.W.S.
Continuity	..	..	Hurst.

Class B. White Boston or Trocadero types

The main distinguishing feature for this class as a whole is the characteristic twist or convolution at the leaf edges.

Group B1—White seed

Medium-green plants with hearts considerably lighter than outer leaves. Outer leaves appear leathery and lower whorl lies on the ground. Outer heart leaves reflexed at edges to give slight frilled appearance to apex of heart. Hearts are very rounded, firm, well covered and are large for the size of the plant. Blistering is slight. This group is very popular for growing under Dutch lights and also as a summer lettuce. Very susceptible to *Botrytis*, downy mildew, tipburn and mosaic. Average period from sowing to hearting, 66 days. Average period from hearting to bolting, 18 days.

<i>Synonyms.</i>			<i>Suppliers.</i>
All Heart Exhibition	..	..	Bees
All Seasons	..	..	Harrison (<i>Leicester</i>)
Attraction	..	..	Carter
Attraktion No. 379	..	..	Ohlsens Enke (Denmark)
Bohemia	..	..	S. Müller (Switzerland)
Borough Wonder	..	..	Clucas
Early Mammoth	..	..	Woodward
Ideal	..	..	Unwin
Improved Unrivalled	..	..	Sutton
Kirkgate Market	..	..	Woodhead

<i>Synonyms.</i>	<i>Suppliers.</i>
Long Standing	Leighton
Market Favourite	Cooper Taber
Market Favourite/51'	Ohlsens Enke (Denmark)
Market Favourite Reselected ..	Woodward
Market King	Elsom
New Market	Dickson, Brown & Tait
Northern Queen	Bunting
Osmaston Beauty	C.W.S.
Our Choice	Croll
Paragon	Barr
Perfect	W. W. Johnson
Pure Green Trocadero	Harrison (<i>Maidstone</i>)
Reliance	Pennel
Salad Favourite	Dickson, Brown & Tait
Spring Queen	Bunting
Summer Cabbage	Harrison (<i>Maidstone</i>)
Tägerwiler Original	S. Müller (Switzerland)
Toogood's Unrivalled	Toogood
Trocadero Improved Market	
Strain	Hurst
Unrivalled	Yates
White Boston	Bunting
White Heart	Toogood
Winter Favourite	Finney

Group B2—White seed

Behaviour and form of this group is identical with group B1 but all plants are dark green. This group has arisen as a mutation to dark green colour from group B1.

<i>Synonyms.</i>	<i>Suppliers.</i>
Cobham Green	Tozer
Green Boston	Mazoe Estate, S. Rhodesia.
White Boston	Mazoe Estate, S. Rhodesia.

Group B3—Black seed

Medium-green, larger (11-13 inches), more delicate looking plants than group B1. Heart is of distinct group B1 type—solid, spherical, and very well folded and covered with a diameter of 4-4½ inches. Outer leaves few, lower ones resting on the ground, hardly blistered and not quite as convoluted as general type. The plants look very attractive and tender. Susceptible to *Botrytis*, downy mildew and tipburn. Average period from sowing to hearting, 67 days. Average period from hearting to bolting, 14 days.

<i>Synonyms.</i>	<i>Suppliers.</i>
Cheshire Green	Speed
Feltham Greenheart	Watkins & Simpson
Greenheart	Dobie

Group B4—Black seed

Very similar to group B3, but rather more crinkly. Susceptible to the same diseases. Average period from sowing to hearting, 66 days. Average period from hearting to bolting, 23 days.

<i>Supplier.</i>
Wonder van Voorburg Sluis en Groot (Netherlands)

Group B5—White seed

Similar to group B1 in colour, size and form, but heart is very blistered and has many outer leaves which do not overlap but form an erect frill around it, thus giving the whole heart a deformed and loose appearance. The true heart is very solid and is about 3 inches in diameter. Lower leaves few and similar to B1. Not very attractive due to outer heart leaves and large amount of blistering. This variety is often grown in the winter under Dutch lights. Very susceptible to *Botrytis* and downy mildew. Average period from sowing to hearting, 70 days. Average period from hearting to bolting, 18 days.

Supplier.

Sans Rivale Vilmorin (France)

Group B6—White seed

Very similar to group B5 but larger and more blistered. Heart formation similar and fairly solid but distortion is increased. Plants are rather loose and untidy with many outer light to medium green leaves. Diameter of whole plant approximately 13-14 inches and heart diameter 3 inches. This variety is often grown in the winter under Dutch lights. Very susceptible to *Botrytis*, downy mildew and tipburn. Average period from sowing to hearting, 71 days. Average period from hearting to bolting, 10 days.

Supplier.

Attraktion S. Müller (Switzerland)

Group B7—White seed

Almost identical with group B6 but fewer outer leaves. Susceptible to *Botrytis* and downy mildew. Average period from sowing to hearting, 74 days. Average period from hearting to bolting, 24 days.

*Synonyms.**Suppliers.*

4013 Beltsville (U.S.A.)
Helvetia S. Müller (Switzerland)

Group B8—White seed

Rather similar to group B1 in form, but slightly looser and with leaves tending towards group A1 type. The colour and the degree of blistering are the same as group A1 but there is red tingeing of the leaf edges. Heart is rather flattened, not very well covered and of 3-4 inches in diameter. Quite a large number of outer leaves, the plant being 11 inches in diameter. Susceptible to *Botrytis* and downy mildew. Average period from sowing to hearting, 71 days. Average period from hearting to bolting, 12 days.

*Synonyms.**Suppliers.*

Balmoral Finney
Big Boston Ferry Morse (U.S.A.)
Ideal Sutton
Paragon Webb
Perfection Fogwill
Trocadero Hurst

Group B9—Black seed

Similar colouring to group B8 but the plants are larger and considerably looser. The plants are, in fact, a larger more leafy form of the previous group. Heart (diameter 4½ inches) is loose and fairly soft and yielding. Very susceptible to *Botrytis* and downy mildew. Average period from sowing to hearting, 73 days. Average period from hearting to bolting, 11 days.

*Synonyms.**Suppliers.*

Do. X. Original S. Müller (Switzerland)
La Préférée Vilmorin (France)
Lorthois Vilmorin (France)
Trocadère à graine noire .. Vilmorin (France)

Class C. Webb's Wonderful or Curly Crisp types

This class is characterised by the extremely serrate and frilly nature of its leaf edges. The majority of the groups consist of plants which have a very crisp texture and the leaves are very brittle.

Group C1—White seed

Crisp plants with dark green, fairly blistered outer leaves. All leaves have small irregular serrations on their outer edge. Hearts are quite solid, large and spherical (average diameter 7 inches), being a lighter green colour. Leaves overlap well, the top two just meeting across the top of the heart. There is very little waste in this group as there are few outer leaves and most of the plant is composed of heart. Very susceptible to *Botrytis* and slightly susceptible to downy mildew and tipburn. Average period from sowing to hearting, 76 days. Average period from hearting to bolting, 25 days.

<i>Synonyms.</i>				<i>Suppliers.</i>
A.1	..	..	..	Sutton
Champion	..	..	..	Clibran
Giant	..	..	..	Dickson, Brown & Tait
Giant Drumhead	..	..	..	Dunn
Henderson's New York	..	..	..	P. Lawson
Howcroft's Monster	..	..	..	Cooper Taber
Monster	..	..	..	Finney
Neapolitan	..	..	..	Cooper Taber
New York	..	..	..	Sharpe
New York	..	..	..	Little & Ballantyne
New York 12	..	..	..	Agassiz, Ottawa (Canada)
New York 515 (F 1843)	..	..	..	Saanichton, Ottawa (Canada)
Perfect	..	..	..	Leighton
Summer Standwell	..	..	..	Toogood
Webb's Wonderful	..	..	..	Webb (<i>Stourbridge</i>)
Webb's Wonderful	..	..	..	Clarence Webb
Wonderful	..	..	..	Unwin
Wonderful	..	..	..	Daehnfeldt (Denmark)

Group C2—White seed

Very similar to the above group in most respects, but the heart is not as well defined or as well covered. The heart is also slightly darker, the whole plant being rather more blistered and appearing more coarse than those of group C1. Disease susceptibility as for the above group. Average period from sowing to hearting, 76 days. Average period from hearting to bolting, 21 days.

				<i>Supplier.</i>
Chou de Naples	..	..	..	Vilmorin (France)

Group C3—Black seed

Very similar to group C1 but has smaller hearts. Average period from sowing to hearting, 80 days. Average period from hearting to bolting, 25 days. Rather more resistant to *Botrytis* than group C1 but susceptible to the other diseases quoted.

				<i>Supplier.</i>
Imperial 847	..	..	..	Ferry Morse (U.S.A.)

Group C4—White seed

Very similar to, but not synonymous with group C1. All performance details are identical.

				<i>Supplier.</i>
19551-M	..	..	..	Whitaker, La Jolla, California (U.S.A.)

Group C5—White seed

Similar type to group C1 the leaves being darker, crisper and appearing more leathery, the amount of blistering has increased and the leaf edges have deeper serrations. Central heart leaves do not overlap as closely as those of C1 and the heart appears looser. It is a very solid heart, however, one leaf covering it completely. The variety Imperial 44 appears synonymous with the other two varieties in this group until the stage of market maturity is reached. The heart then is slightly more wrinkled, slightly darker green and tends to split more easily than the other members of this group. Very susceptible to *Botrytis* and tipburn, but slightly resistant to downy mildew. Average period from sowing to hearting, 83 days. Average period from hearting to bolting, 18 days.

<i>Synonyms.</i>				<i>Suppliers.</i>
77	..	..	..	Lewis, Penn. A.E.S. (U.S.A.)
Imperial 44	..	..	..	Ferry Morse (U.S.A.)
Imperial 152	..	..	..	Ferry Morse (U.S.A.)

Group C6—White seed

Rather similar to the above group, with very large hearts. Susceptible to *Botrytis* and downy mildew. Average period from sowing to hearting, 79 days. Average period from hearting to bolting, 22 days.

<i>Synonyms.</i>				<i>Suppliers.</i>
Great Lakes	..	..	..	Saanichton, Ottawa (Canada)
Hercules	..	..	..	Dobbie
K-1	..	..	..	Ferry Morse (U.S.A.)
Imperial 101	..	..	..	Ferry Morse (U.S.A.)
Imperial 615	..	..	..	Ferry Morse (U.S.A.)
Imperial 749	..	..	..	Ferry Morse (U.S.A.)

Group C7—White seed

Very similar to group C6 but the heart forms a slightly smaller proportion of the whole plant. All leaves are slightly reflexed at their edges and are also very serrate. Susceptible to *Botrytis* and downy mildew. Average period from sowing to hearting, 86 days. Average period from hearting to bolting, 16 days.

				<i>Supplier.</i>
Greatheart	..	..	..	C.W.S.

Group C8—White seed

Large plants with spreading dark green leaves. These are less blistered than former groups but are of an irregular shape, being rather fan-like with deep and irregular serrations. The heart is very large, but nestles within the large floppy outer leaves. The heart is a lighter green, but the colour is graded from it to the outer leaves, the change being less distinct than in group C1. Hearts are very solid and reach 8 inches in diameter (plant diameter 16-18 inches). Some plants when cut at market maturity in Wellesbourne have weighed almost four pounds.

Although all varieties within this group can be regarded as morphological synonyms there are two varieties which show slight differences. Premier Great Lakes is rather larger than the average, has a slightly lighter heart and succumbs less rapidly to *Botrytis*. Great Lakes 8979 has been the most disease-free of all of the varieties listed below, being only slightly affected by *Botrytis* and downy mildew. The remainder is highly susceptible to *Botrytis*, and moderately susceptible to downy mildew, while all the varieties in the group show negligible tipburn. Average period from sowing to hearting, 85 days. Average period from hearting to bolting, 25 days.

<i>Synonyms.</i>				<i>Suppliers.</i>
Giant Crisphead	..	..	..	Dobie
Great Lakes	..	..	..	Harrison (Leicester)

<i>Synonyms.</i>				<i>Suppliers.</i>
Great Lakes	..	..	..	Asgrow (U.S.A.)
Great Lakes M.T.	..	..	..	Ferry Morse (U.S.A.)
Great Lakes 407	..	..	..	Whitaker, La Jolla, California (U.S.A.)
Great Lakes 428	..	..	..	Whitaker, La Jolla, California (U.S.A.)
Great Lakes 659	..	..	..	Whitaker, La Jolla, California (U.S.A.)
Great Lakes 8979	..	..	..	Ferry Morse (U.S.A.)
Premier Great Lakes	..	..	..	Ferry Morse (U.S.A.)

Group C9—White seed

A small type of C8 which has a slightly more 'frilly' appearance. Heart is slightly more conical than the above group. Susceptible to *Botrytis*, tipburn and downy mildew. Maturity periods, as above group. This variety was intended for the United States market but is not now to be distributed.

				<i>Supplier.</i>
Cornell 85	..	..	..	Cornell University (U.S.A.)

Group C10—Black seed

Very similar to group C8 but smaller and slightly lighter green with a more glaucous surface. All leaves are slightly reflexed, the heart being completely covered by a very reflexed leaf. An attractive type which is slightly more blistered than above group. Slightly susceptible to downy mildew and *Botrytis* but fairly resistant to tipburn. Maturity periods as for group C8.

				<i>Supplier.</i>
Alaska	..	..	..	U.S.D.A., Beltsville (U.S.A.)

Group C11—White seed

Quite similar to group C8 but rather smaller plants, being about 14 inches diameter. Diameter of heart 6 inches, but it splits very quickly on reaching market maturity. Very susceptible to *Sclerotinia* and *Botrytis*; less susceptible to downy mildew. Average period from sowing to hearting, 85 days. Average period from hearting to bolting, 18 days.

				<i>Supplier.</i>
21174-M	..	..	..	Whitaker, La Jolla, California (U.S.A.)

Group C12—White seed

Very similar to group C8 but slightly lighter green, especially the hearts which are very solid and well covered. Very susceptible to *Botrytis* and fairly susceptible to downy mildew. Average period from sowing to hearting, 86 days. Average period from hearting to bolting, 21 days.

<i>Synonyms.</i>				<i>Suppliers.</i>
Penn Lake	..	..	..	Whitaker, La Jolla, California (U.S.A.)
Penn Lake	..	..	..	Lewis, Penn. A.E.S. (U.S.A.)
171	..	..	..	Lewis, Penn. A.E.S. (U.S.A.)

Group C13—Black seed

A distinct group. Dull, dark green leaves. Few blisters, leaf edges showing 'frilling' rather than serrations. Heart formation commences with a 'tubular' growth as in spring cabbage, the leaves eventually turning in to form a solid spherical heart. Slightly susceptible to *Botrytis*, downy mildew and tipburn. Average period from sowing to hearting, 82 days. Average period from hearting to bolting, 23 days.

				<i>Supplier.</i>
4164	..	..	..	U.S.D.A., Beltsville (U.S.A.)

Group C14—Black seed

Very dark green plants with leaf type like group C8 but general habit is like group C1. Hearts are large, round and firm, being quite well covered. Slightly susceptible to downy mildew and tipburn. Average period from sowing to hearting, 78 days. Average period from hearting to bolting, 25 days.

					Supplier.
Jade	..	..	..	..	U.S.D.A., Beltsville (U.S.A.)

Group C15—White seed

Very similar to group C8 but the plants are slightly more glossy, giving a darker green appearance. Leaf edge serrations are very deep, the whole leaf edge having a very ragged appearance when viewed from directly above. The heart is blistered as in group C8 but is a rather darker green. Very susceptible to *Botrytis* and fairly susceptible to downy mildew. Average period from sowing to hearting, 86 days. Average period from hearting to bolting, 21 days.

Synonyms.					Suppliers.
Cornell 456	..	..	..	..	Ferry Morse (U.S.A.)
Cornell 456	..	..	..	..	Cornell University (U.S.A.)
Imperial 456	..	..	..	..	Whitaker, La Jolla, California (U.S.A.)
Imperial 456	..	..	..	..	Hikida, Univ. of Manitoba (Canada)

Group C16—White seed

Almost synonymous with group C8 but outer leaves are slightly more shiny and hearting is slightly earlier. Leaf serrations are more marked and the plants are smaller. Hearts split very easily at maturity and appear very ragged even when unsplit, due to the deep leaf serrations. Diameter of plant 9-12 inches. Susceptible to *Botrytis*, downy mildew and *Sclerotinia*. Average period from sowing to hearting, 83 days. Average period from hearting to bolting, 20 days.

Synonyms.					Suppliers.
20609-M	..	..	..	..	Whitaker, La Jolla, California (U.S.A.)
21094-M	..	..	..	..	Whitaker, La Jolla, California (U.S.A.)
21519-M	..	..	..	..	Whitaker, La Jolla, California (U.S.A.)

Group C17—White seed

Rather similar to group C7 but has a slightly lighter coloured and softer heart. It is a smaller lettuce with fewer blisters and rather more spreading outer leaves. Hearting characteristics are more typical of the previously mentioned group, than of group C1. The leaf edges are more like the latter group, however. The leaves tend to surround the heart (which is spherical) in such a manner that it appears rather 'spring cabbagey'. Susceptible to *Botrytis* and believed completely immune to downy mildew. Average period from sowing to hearting, 77 days. Average period from hearting to bolting, 23 days.

					Supplier.
45634-M	..	..	..	..	Whitaker, La Jolla, California (U.S.A.)

Group C18—White seed

This is a light green version of group C1. The plants are smaller, however, (10-11 inches diameter) and with smaller hearts (diameter 4 inches) which are fairly soft and soon break. This group and all those following, i.e. C18 to C21 have more of a butterhead texture. Slightly susceptible to downy mildew and fairly susceptible to *Botrytis* and tipburn. Average period from sowing to hearting, 78 days. Average period from hearting to bolting, 20 days. It is understood that Laibacher Is which is a

member of this group, should be red tinged, but in the sample examined the variety was synonymous with other members of the group.

<i>Synonyms.</i>				<i>Suppliers.</i>
Avalanche	..	..	..	Finney
Blonde Blockhead	..	..	..	Sharpe
Hanson	..	..	..	Hurst
Ivea	..	..	..	Weibull (Sweden)
Laibacher Is	..	..	..	Daehnfeldt (Denmark)
Peerless	..	..	..	Croll
Summer Perfection	..	..	..	Arnold
Summer Salad	..	..	..	Dunn
Verdant Green	..	..	..	Tonkin

Group C19—White seed

A very crinkly lettuce of similar colour to the above group, but the lower leaves are a slightly darker green. The hearts are very light yellow green, fairly large (7-8 inches diameter) and rather soft. Leaf edges are only slightly serrate, the whole plant being very blistered. Hearts are always loose and do not hold very well, becoming tip-burnt at a very early marketing stage. Very susceptible to tipburn and fairly susceptible to downy mildew and *Botrytis*. Average period from sowing to hearting, 75 days. Average period from hearting to bolting, 26 days.

<i>Synonyms.</i>				<i>Suppliers.</i>
Allheart	..	..	..	Woodhead
Blonde	..	..	..	Pennel
Coral Queen	..	..	..	J. Forbes
Crystal Cabbage	..	..	..	Ryder
Denver Market	..	..	..	Cullen
Dickson's Acme	..	..	..	Little & Ballantyne
Early Wonderful	..	..	..	Toogood
Elsom's Favourite	..	..	..	Elsom
Excelsior	..	..	..	Dickson, Brown & Tait
Favourite	..	..	..	Sutton
Frilled Wonder	..	..	..	C.W.S.
Greatheart	..	..	..	Webb
Green Favourite	..	..	..	Barr
Ohio	..	..	..	Sharpe
Perpetual	..	..	..	Carter
Prince of Lettuce	..	..	..	Pennel
Royal Malta	..	..	..	Bunting
Selected Ohio	..	..	..	Fogwill
Summer Pearl	..	..	..	Dickson (<i>Hawlmork</i>)

Group C20—White seed

Very similar to group C18 but larger (16 inches diameter) more leafy and with a poorly formed heart. This group appears more resistant to disease than group C18, being slightly susceptible to downy mildew and relatively unaffected by the diseases which affect C18. Average period from sowing to hearting, 76 days. Average period from hearting to bolting, 18 days.

<i>Synonyms.</i>				<i>Suppliers.</i>
Batavia Blonde de Paris	..	..	..	Vilmorin (France)
Royal Malta	..	..	..	Harrison (<i>Leicester</i>)

Group C21—White seed

Very similar to group C18 but slightly larger (12-13 inches diameter), slightly darker green and larger heart (diameter 6-8 inches) with red tingeing. The hearts are

fairly soft and soon break, however. Laibacher Eis as included in this group is the correct form. Iceberg belongs to this group but it is very common for this name to be used for members of the C1 group in the United States.

This group is divisible into three parts based on bolting periods. Group C21A bolts 7 to 10 days earlier than group 21B, and this group bolts 4 to 5 days earlier than group 21C. Average period from sowing to hearting, 74 days for all groups. Average period from hearting to bolting, 6 days for group C21A. All are slightly susceptible to *Botrytis*, downy mildew and tipburn.

	<i>Synonyms.</i>				<i>Suppliers.</i>
A	Iceberg	..	..	..	Hurst
	Supreme	..	..	..	Sutton
	Batavia blonde à bord rouge	..	..	..	Vilmorin (France)
	Cool and Crisp	..	..	..	Arnold
B	Holborn Standard	..	..	..	Carter
	Iceberg	..	..	..	Little & Ballantyne
	Iceberg	..	..	..	Speed
	Improved Malta	..	..	..	Yates
	Lincoln Giant	..	..	..	Pennel
C	Batavia	..	..	..	S. Müller (Switzerland)
	Laibacher Eis	..	..	..	S. Müller (Switzerland)

DISCUSSION

From the preceding evidence it can be seen that the degree of duplication in the names of summer lettuce is quite appreciable. Some duplication is obviously unavoidable, especially when translations are made from one language to another. In spite of the degree of synonymy there still exists a large amount of diversity of type, forming a good reservoir of breeding material. The details regarding periods of maturity and the susceptibility to disease as described for each synonymous group are results collected at Wellesbourne and therefore are not necessarily of general application, although probably nearly correct for most of the lettuce growing areas in the U.K. Incidence of disease is based on observation and not experiment, and omission of a specific disease does not necessarily imply resistance to or immunity from it.

Synonymy is extremely difficult to assess amongst the American varieties in Class C and this is probably due to the presence of numbers of strains which are selected for particular environments in that country. At Wellesbourne these varieties have indicated very few, if any, morphological differences and a number which are probably quite distinct in their own environments have consequently been classed as synonyms.

From the 232 varieties studied, 60 groups are shown to be distinct from one another, but the groups vary considerably in size, the largest being those which contain the most popular types. Included in the above classification are 130 British varieties, these being placed into 24 distinct groups, the remaining 102 varieties being split up between 36 groups. The reasons that only relatively few types are grown in this country may be one or more of the following :—

- (a) The components of the 36 groups of foreign lettuce may be considered undesirable for consumption in this country, and consequently they have no equivalent British types.
- (b) Allied to (a) is that of varying tastes of different peoples. In this country the butterhead lettuce is still, without doubt, the most popular type, while in the United States of America, for example, public taste prefers the crisp type. To this is added another factor, that of carriage over long distances. The demand everywhere is always for fresh vegetables and over the vast distances in the United States of America it has been found that the crisp types pack well in ice and arrive crisp at the retail store.

- (c) There is a constant renaming of the popular types in this country, both well-intentioned and otherwise. In general, varieties catalogued as 'selections' from other known varieties are identical with the original stock. Selections amongst lettuce are probably made on some apparent difference in type or behaviour but due to the almost complete homozygosity of lettuce, the selections rarely appear different from the original stock in the next generation. The lettuce types which are most popular in this country are those represented in groups A1, A6, B1 and C1, the number of differently named British varieties within these groups being, respectively, 11, 9, 29 and 13. In the general interest it would be beneficial to restrict the number of names given to any one type of lettuce. The christening of new types is obviously desirable but, to quote one example, a true and distinctive novelty had at least two extra new names only two years after it was produced. These so-called 'new' varieties were derived from the same mother seed since the two firms concerned do not produce their own.

SUMMARY

232 varieties of summer lettuce have been grown at the N.V.R.S. Wellesbourne, and are placed into 60 synonymous groups. Methods of delimiting synonymous groups, and details of each of these groups are given. An index of varietal names is attached as an appendix.

Acknowledgment

I should like to thank Dr. Haigh for all the help and encouragement which he has given me in carrying out this work.

REFERENCES

- (1) MORSE, L. L. (1930). *Field notes on lettuce*. San Francisco and Detroit, Ferry Morse Seed Co., 3rd ed.
- (2) BRIAN, P. W. (1936). Varieties of cabbage lettuce and their classification. *J. Pomol.*, **14**, 26-38.
- (3) MIGUEL, M. C. de S. M. C. (1953). Identification of lettuce (*Lactuca sativa* L.) varieties on the basis of seed and young plant characteristics. *Proc. Int. Seed Test. Ass.*, **18**, 180-8.
- (4) THOMPSON, R. C. (1943). Inheritance of seed color in *Lactuca sativa*. *J. Agric. Res.*, **66**, 441-6.
- (5) DURST, C. E. (1929). Inheritance in Lettuce. *Science*, **69**, 553-4.
- (6) THOMPSON, R. C. (1938). Genetic relations of some color factors in lettuce. *Tech. Bull. U.S. Dep. Agric.*, 620.

SUMMER LETTUCE SYNONYMY INDEX

Variety.	Class (Initial) and Group (Numeral)	Variety.	Class (Initial) and Group (Numeral)
A.1	C.1	Batavia blonde de Paris ...	C.20
Ace of Hearts No. 381 ...	A.1	Bautzener dauerkopf ...	A.19
Alaska	C.10	Berlin	A.17
Allheart	C.19	Berliner Gul	A.17
All Heart Exhibition ...	B.1	Bibb	A.27
All Seasons	B.1	Big Boston	B.8
All the Year Round ...	A.1	Blonde	C.19
All the Year Round Selected	A.1	Blonde Blockhead ...	C.18
Attraction	B.1	Blonde d'été	A.8
Attraktion	B.6	Blonde du Cazard ...	A.5
Attraktion No. 379 ...	B.1	Bohemia	B.1
Avalanche	C.18	Bonte Chili	A.23
Balmoral	B.8	Borough Wonder ...	B.1
Batavia	C.21	Brant	A.26
Batavia blonde à bord		Brauner Troitzkopf ...	A.28
rouge	C.21	Bronze Beauty	A.30

SUMMER LETTUCE SYNONYMY INDEX—*contd.*

<i>Variety.</i>	<i>Class (Initial) and Group (Numeral)</i>	<i>Variety.</i>	<i>Class (Initial) and Group (Numeral)</i>
California Cream Butter...	A.24	Ideal	B.8, B.1
Cazard	A.5	Imperial 44	C.5
Cazard No. 380	A.5	Imperial 101	C.6
Cazard Elite Qual	A.5	Imperial 152	C.5
Champion	A.1, A.21, C.1	Imperial 456	C.15
Chavigny	A.11	Imperial 615	C.6
Cheshire Green	B.3	Imperial 749	C.6
Chou de Naples	C.2	Imperial 847	C.3
Cobham Green	B.2	Improved Malta	C.21
Commodore Nutt	A.14	Improved Unrivalled	B.1
Continuity	A.30	Ivea	C.18
Cool and Crisp	C.21	Jade	C.14
Coral Queen	C.19	K-1	C.6
Cornell 85	C.9	Kirkgate Market	B.1
Cornell 456	C.15	Laibacher Eis	C.21
Covent Garden	A.1	Laibacher Is	C.18
Criterion	A.1	Langport Gem	A.13
Crystal Cabbage	C.19	La Préférée	B.9
Cyrius oder Mogul	A.3	Lincoln Giant	C.21
Denver Market	C.19	Long Standing	B.1
Dickson's Acme	C.19	Long Standing Trocadero	A.3
Distinction	A.5	Lorthois	B.9
Do. X. Original	B.9	Lord Kitchener	A.6
Dryweather	A.6, A.12	Market Favourite	B.1
Du bon Jardinier	A.21	Market Favourite/51	B.1
Early Exquisite	A.13	Market Favourite Reselected	B.1
Early Mammoth	B.1	Market Giant	A.1
Early Market	A.1	Market King	B.1, A.7
Early Market Allheart	A.1	Market Wonder	A.12
Early Wonderful	C.19	Matchless	A.1
Elsom's Favourite	C.19	Merveille des Quatre Saisons	A.29
Evesham Market	A.6	Mignonette	A.25
Excelsior	C.19	Monument	A.6
Exhibition Cabbage	A.1	Monster	C.1
Favourite	C.19	Monstrueuse ronde d'été	A.20
Feltham Greenheart	B.3	Neapolitan	C.1
Feltham King	A.6	New Queen	A.12
Feltham Wonder	A.6	New Market	B.1
Frilled Wonder	C.19	New York	C.1
Fürchtenichts	A.1	New York 12	C.1
Giant	C.1	New York 515 (F 1843)	C.1
Giant Crisphead	C.8	Northern Queen	B.1
Giant Drumhead	C.1	Ohio	C.19
Gloire de Nantes	A.6	Osmaston Beauty	B.1
Gotte lente à monter	A.16	Our Choice	B.1
Greatheart	C.7, C.19	Paragon	B.8, B.1
Great Lakes	C.6, C.8	Peerless	C.18
Great Lakes M.T.	C.8	Penn Lake	C.12
Great Lakes 407	C.8	Perfect	B.1, C.1
Great Lakes 428	C.8	Perfection	B.8
Great Lakes 659	C.8	Perpetual	C.19
Great Lakes 8979	C.8	Pioneer	A.6
Green Boston	B.2	Premier Great Lakes	C.8
Green Favourite	C.19	Prince of Lettuce	C.19
Greenheart	B.3	Pure Green Trocadero	B.1
Green Mignonette	A.15	Reine de juillet	A.5
Grosse Blonde Paresseuse	A.4	Reliance	B.1
Grosse Brune Paresseuse	A.22	Resistent	A.12
Hanson	C.18	Royal Malta	C.19, C.20
Heidelburger Schloss	A.5	Rüdiger	A.9
Helvetia	B.7	Rufford Triumph	A.6
Henderson's New York	C.1	Salad Favourite	B.1
Hercules	C.6	Sans Rivale	B.5
Hjerter Es	A.1	Selected All the Year Round	A.1
Holborn Standard	C.21		
Howcroft's Monster	C.1		
Iceberg	C.21		

SUMMER LETTUCE SYNONYMY
INDEX—*contd.*

<i>Variety.</i>	<i>Class (Initial) and Group (Numeral)</i>
Selected Ohio	C.19
Spring Beauty	A.6
Spring Queen	B.1
Stenhoved Guldgul	A.18
Stonehead Golden Yellow	A.18
Stonehead Yellow	A.18
Stubborn headed Brown	A.28
Stubborn headed Yellow	A.2
Stuttgarter Dauerkopf ...	A.3
Stuttgarter Sommer ...	A.3
Summer Cabbage	B.1
Summer Giant	A.11
Summer Market	A.10
Summer Pearl	C.19
Summer Perfection	C.18
Summer Salad	C.18
Summer Standwell	C.1
Supreme	C.21
Syston Gloria	A.6
Tägerwiler Original ...	B.1
Tom Thumb	A.13
Tom Thumb Selected ...	A.13
Toogood's Unrivalled ...	B.1
Trocadère à graine noire...	B.9
Trocadero	B.8

<i>Variety.</i>	<i>Class (Initial) and Group (Numeral)</i>
Trocadero Improved Market	
Strain	B.1
Trotzkopf brauner	A.28
Trotzkopf gelber	A.2
Unrivalled	B.1
Verdant Green	C.18
Webb's Wonderful	C.1
Wheeler's Tom Thumb ...	A.13
White Boston	B.1, B.2
White Favourite	A.11
White Heart	B.1
Wonderful	C.1
Winter Favourite	B.1
Wunder von Stuttgart ...	A.1
Wonder van Voorburg ...	B.4
Zwart Duitsch	A.1
77	C.5
171	C.12
4013	B.7
4164	C.13
19551-M	C.4
20609-M	C.16
21094-M	C.16
21174-M	C.11
21519-M	C.16
45634-M	C.17

CHEMISTRY REPORT

By F. HAWORTH

During the autumn of 1953 three long-term experiments were marked out in Soakwaters and soil samples were collected from each of the 354 plots involved. The soil samples were dried and stored and the analysis of these samples was started in January 1954. The analyses were not completed by the end of the year under review since all available staff were engaged on outside work in connection with field experiments from March to September 1954. For the same reason, it was not possible to complete the detailed soil survey of the Station started in 1953. In addition to these new experiments, the two field experiments with synthetic soil conditioners were continued but since no further indications of beneficial effects on crop growth were obtained as a result of the conditioner treatments, these experiments were abandoned at the end of the year. Soil samples were taken from all the plots at the end of the experiments. Details of crop performance and the results of soil aggregate analyses are given elsewhere in this report (1).

Particulars of the three long-term experiments are presented for information and future reference but yield records are not included in this report. The first crops were secured from these experiments during 1954 and apart from one phase (red beet) in one experiment, the standard errors of the various experiments were reasonable.

Cultivation experiment

This experiment is intended to determine the effect of varying depths of ploughing and rotavating, and varying depths of manure incorporation, on the yield and composition of vegetables in a three year rotation, on the physical and chemical condition of the soil and on the distribution of the roots of the crops grown. The experimental treatments are :—

- A 1. Deep ploughing 14–16 inches before each crop.
2. Shallow ploughing 6–7 inches before each crop.
3. Shallow ploughing 6–7 inches plus subsoiling 16–18 inches before each crop.
4. Rotavating 6–7 inches as the primary cultivation.
- B 1. Nitrogen only.
2. Manure before ploughing (phosphate, potash and F.Y.M., not nitrogen).
3. Manure after ploughing (except F.Y.M.).

The two groups A and B are combined factorially to give 12 treatments in all.

The experiment is of a randomised block design having 12 plots (12×8 yd.) per block, with two replications and three phases giving 72 plots in all. The three phases permit each crop of the rotation, which consists of peas, spring cabbage, leeks and Brussels sprouts, to be observed every year.

The rate of application of manures is dependent upon the kind of crop except that the F.Y.M. treatment is constant at 20 tons per acre per crop, i.e. 80 tons per acre in three years. The individual crops are given the following quantities of nutrients :—

Crop	lb. per acre		
	N	P ₂ O ₅	K ₂ O
Peas	Nil	36	72
Spring cabbage ..	46	36	48
Leeks	62	36	72
Brussels sprouts ..	62	36	72

The time of application depends upon the crop being grown. The pH of the soil is to be maintained between 6.0 and 7.0 by addition of lime when required.

In general, irrigation will be used only when necessary to ensure the establishment of a crop or to save a crop from failure due to prolonged drought. Recognised protective measures will be used against any pests and diseases which may appear.

Nitrogen experiment

The object of this experiment is to compare hoof and horn meal and nitrochalk (applied in various ways) as sources of nitrogen for vegetables using a rotation of early potatoes, spring cabbage, leeks and carrots. The effect of the various nitrogenous manures on soil conditions will also be studied.

The experimental treatments are :—

- A 1. F.Y.M.
 - 2. No F.Y.M.
 - B 1. Organic N as hoof and horn meal
 - 2. One dose (N) of nitrochalk
 - 3. Four doses of $\frac{1}{4}$ N
 - 4. Four doses of $\frac{1}{8}$ N
 - 5. Four doses of $\frac{3}{8}$ N
- } as nitrochalk

The amounts of N supplied in treatments B1 and B2 are equal. The two groups A and B are combined factorially to give ten treatments in all.

The experiment is of a randomised block design having 10 plots per block, four replications and three phases, making 120 plots in all. The plots are 10×8 yd. The manurial levels are :—

Crop	lb. per acre		
	N	P ₂ O ₅	K ₂ O
Early potatoes ..	62	36	60
Spring cabbage ..	93	36	48
Leeks	62	36	72
Carrots	31	36	48

The manurial treatments F.Y.M., organic N, N and the first $\frac{1}{8}$ N, $\frac{1}{4}$ N, $\frac{3}{8}$ N applications are to be worked into the seed bed or plant bed, except for the spring cabbage crop where no inorganic nitrogen is to be given until the spring. The remaining fractional nitrogen dressings are to be applied when the weather is suitable during the growth of the crops and not at specific time intervals. Lime will be applied as required to keep the pH of the soil between 6.0 and 7.0.

N.P.K. factorial experiment

The main purposes of this experiment are to provide plant material for the analytical study of mineral nutrition of certain vegetables, and to provide, in due course, soils of known manurial histories. The experimental treatments are all possible combinations of the factors :—

- (1) N₁, N₂, N₃
- (2) K₀, K₁, K₂
- (3) P₀, P₁, P₂
- (4) F.Y.M.₀, F.Y.M.₁

giving 54 treatments in all.

The experiment is of a randomised block design having one replicate. The plot size is 8×8 yd. and there are three phases. The three-year rotation is early potatoes, spring cabbage, carrots and red beet. The manurial levels are as follows :—

Crop	lb. per acre			tons per acre F.Y.M. ₁
	N ₁	P ₁ (P ₂ O ₅)	K ₁ (K ₂ O)	
Early potatoes ..	31.0	18	48	20
Spring cabbage ..	46.5	18	36	20
Carrots	15.5	18	48	20
Red beet	31.0	18	48	20

The levels N₂, P₂, K₂ are twice the levels N₁, P₁, K₁ respectively, and N₃ is three times N₁.

Irrigation will be used if necessary to establish or save a crop and recognised pest control measures will be used as required.

REFERENCE

HAWORTH, F. and NELDER, J. A. (1955). The effect of 'Krilium' on the yield of certain vegetable crops, II. *Ann. Rep. Nat. Veg. Res. Stn.*, 1954, 40.

THE EFFECT OF 'KRILIUM' ON THE YIELD OF CERTAIN VEGETABLE CROPS. II

By F. HAWORTH and J. A. NELDER

This experiment, full details of which were given in the Station's 1953 Report (page 30), was continued during 1954, and this paper deals with the performance of the crops produced during that year on phase I and during 1953-54 on phase II.

Phase I. Second cycle—first crop—early peas

Seed of the variety Laxton's Progress was sown early in April 1954, but the first sowing failed owing to indifferent germination together with the depredations of rooks, moles and mice. The experiment was resown during the last week of April using the variety Onward. Germination was good and an even stand of plants was obtained. The crop was harvested on 31st July, 1954, and averaged over 6 tons per acre of marketable pods. The mean weights per plot of marketable pods (converted to tons per acre) are shown in Table I whilst the corresponding amounts of haulm are shown in Table II.

TABLE I
Yield of marketable pods in tons per acre

Depth of incorporation	Concentration of 'Kriliium'				Mean
	0	1	2	3	
3 inches	7.21	6.40	6.74	6.31	6.66
3 inches, watered ..	5.56	6.22	5.80	5.47	5.76
6 inches	6.46	6.97	6.82	6.91	6.79
Mean	6.41	6.53	6.45	6.23	6.41

s.e. for comparisons in the same row in the body of the table = ± 0.484 (a)

Least significant difference ($P=0.05$) = ± 0.99 (b)

s.e. for any other comparison in the body of the table = ± 0.446 (c)

Least significant difference ($P=0.05$) = ± 0.93 (d)

s.e. for comparison of row means = ± 0.181 (e)

Least significant difference ($P=0.05$) = ± 0.421 (f)

s.e. for comparison of column means = ± 0.263 (g)

Least significant difference ($P=0.05$) = ± 0.53 (h)

s.e. between strips = 8.2% of the mean (i)

s.e. within strips = 11.0% of the mean (j)

TABLE II
Weight of haulm in tons per acre

Depth of incorporation	Concentration of 'Kriliium'				Mean
	0	1	2	3	
3 inches	7.24	6.79	7.24	7.12	7.10
3 inches, watered ..	9.06	8.19	8.58	8.46	8.58
6 inches	7.12	7.63	7.24	7.54	7.38
Mean	7.81	7.54	7.69	7.71	7.68

(a) ± 0.489 , (b) ± 1.00 , (c) ± 0.563 , (d) ± 1.17 , (e) ± 0.373 , (f) ± 0.86 , (g) ± 0.325 , (h) ± 0.66 , (i) 14.2%, (j) 9.3%. (For key see Table I.)

Watering (two applications of half-an-inch) decreased the yield of marketable peas as compared with the unwatered controls. The amount of haulm was considerably increased by irrigation. The conditioner treatments had no effect on the yield. These results are at variance with those obtained from the corresponding crop of the first cycle when both watering and conditioner treatments materially increased the yield of marketable peas.

This phase of the experiment was discontinued after this crop had been harvested.

Phase II. First cycle—first crop—early peas

Peas of the variety Laxton's Progress were sown by hand at the rate of nine peas per foot in drills 16 inches apart. This tedious method was used to find out whether the standard error per plot could be reduced by ensuring an even distribution of seed and in consequence a more even stand of plants than would be expected from machine drilling.

Germination was rapid and an excellent stand of plants was obtained. The plants in the watered strips grew more rapidly than those on the unwatered strips and eventually flowered three to four days earlier than the latter. The plants on the watered plots were slightly ahead of the unwatered plants at harvest.

The mean yields of marketable pods from the various treatments are shown in Table III and the corresponding weights of haulm are given in Table IV.

TABLE III

Yield of marketable pods in tons per acre

Depth of incorporation	Concentration of 'Krilium'					Mean
	OA	OB	1	2	3	
3 inches	6.93	6.84	6.63	6.82	7.06	6.86
3 inches, watered ..	5.77	6.23	6.14	6.64	6.27	6.21
6 inches	6.60	6.70	6.50	6.62	6.92	6.66
Mean	6.43	6.59	6.40	6.69	6.75	6.57

(a) ± 0.238 , (b) ± 0.49 , (c) ± 0.236 , (d) ± 0.49 , (e) ± 0.101 , (f) ± 0.23 , (g) ± 0.136 , (h) ± 0.27 , (i) 6.2%, (j) 6.3%.

TABLE IV

Weight of haulm in tons per acre

Depth of incorporation	Concentration of 'Krilium'					Mean
	OA	OB	1	2	3	
3 inches	5.35	5.52	5.35	4.46	5.80	5.30
3 inches, watered ..	6.29	6.29	5.93	5.97	6.16	6.13
6 inches	5.19	5.31	5.15	5.27	4.91	5.28
Mean	5.61	5.71	5.48	5.23	5.62	5.57

(a) ± 0.161 , (b) ± 0.32 , (c) ± 0.183 , (d) ± 0.38 , (e) ± 0.114 , (f) ± 0.26 , (g) ± 0.106 , (h) ± 0.21 , (i) 10.2%, (j) 7.7%.

The conditioner-treated plots produced no higher yields than the untreated controls. Watering appeared to depress the yield of marketable pods but this effect was almost certainly caused by delay (owing to shortage of labour) in harvesting the crop. This delay resulted in a proportion of pods becoming over mature and unmarketable, and the proportion was greater on the watered strips than on the unwatered strips.

Phase II. First cycle—second crop—salad onions

The salad onion crop followed the peas, seed of the variety White Lisbon being sown by hand on 29th July, 1953, into hand prepared drills 16 inches apart. Germination was good and the crop developed satisfactorily. Eye assessments of the plots did not indicate any treatment effects. The mild autumn produced rapid growth and in early November a severe attack of *Botrytis* wiped out the crop.

Phase II. First cycle—third crop—lettuce

The third crop of the cycle, summer lettuce (variety Borough Wonder) was spot sown into an apparently ideal seedbed on 5th April, 1954, but the sowing produced a very uneven stand and less than 50 per cent. of points had seedlings showing at the end of the month. Consequently the plots were rotavated (forked in the case of the unrotavated controls) and the crop was resown. A good germination followed and an even stand of plants was obtained. The plants were thinned in two stages. Harvesting began on the 19th July and was complete by the 27th July. About 90 per cent. of the theoretically possible number of heads were secured in good marketable condition.

The mean numbers of marketable heads per plot are shown in Table V and the weight of marketable heads (in tons per acre) are given in Table VI.

TABLE V
Mean numbers of marketable lettuce

Depth of incorporation	Concentration of 'Krilium'					Mean
	OA	OB	1	2	3	
3 inches	55.6	55.4	52.8	56.8	56.0	55.4
3 inches, watered ..	59.2	61.2	60.0	61.6	59.8	60.4
6 inches	53.8	53.2	55.6	56.2	60.4	55.8
Mean	56.2	56.6	56.2	58.2	58.8	57.2

(a) ± 2.32 , (b) ± 4.7 , (c) ± 2.90 , (d) ± 6.0 , (e) ± 1.35 , (f) ± 3.11 , (g) ± 1.68 , (h) ± 3.39 , (i) 8.4%, (j) 6.4%.

TABLE VI
Yield of marketable lettuce in tons per acre

Depth of incorporation	Concentration of 'Krilium'					Mean
	OA	OB	1	2	3	
3 inches	8.66	8.54	7.72	8.05	8.11	8.22
3 inches, watered ..	8.75	8.87	8.57	8.90	8.39	8.70
6 inches	7.90	7.38	8.48	8.17	8.33	8.05
Mean	8.44	8.27	8.25	8.38	8.28	8.32

(a) ± 0.535 , (b) ± 1.08 , (c) ± 0.56 , (d) ± 1.15 (e) ± 0.398 , (f) ± 0.92 , (g) ± 0.309 , (h) ± 0.62 , (i) 11.2%, (j) 9.1%.

The beneficial effects of watering found in the corresponding crop in Phase I of this experiment were substantiated, although in the wet season of 1954 the percentage increase in yield caused by watering was less than in the comparatively dry summer of 1953.

The lettuce crop being late in coming to maturity there was little time to prepare the ground for the fourth crop of the cycle, white turnips. Since the results had shown that the conditioner applications produced no appreciable effects on the growth and yield of crops during 1954, the experiment was brought to a close after the lettuce crop.

Concurrently with the experiments just described, a second experiment was carried out to determine the effect of synthetic soil conditioner 'Merloam', Monsanto's formulation of the calcium salt of vinyl acetate/maleic anhydride co-polymer, C.R.D. 186, in the presence and the absence of peat, on the performance of early lettuce and self-blanching celery grown under Dutch lights.

The experiment, of randomised block design with five replicates, consisted of three levels of 'Merloam', zero, 0.05 per cent., and 0.1 per cent. by weight of the soil with which it was incorporated, and two levels of peat (zero and 12 lb. per Dutch light). These treatments were combined factorially to give six treatments in all, together with two unrotivated control plots, one of which received a dressing of potassium nitrate about mid-growth of the lettuce crop. Each plot consisted of five pairs of double span Dutch lights of which the two outside pairs were guard lights. Each block consisted of two ranges, each of 20 pairs of lights.

First cycle—first crop—lettuce

Before the experiment was begun, straw compost at the rate of 90 tons per acre was forked in. The experimental treatments were applied on the 25th and 26th November, 1952, all incorporation of peat and 'Merloam' being done with a small rotavator. Lettuces were planted out from 7th-9th January, 1953, at 24 plants per light and the crop was harvested from 20th April to 4th May, 1953.

The numbers of first grade heads per light are shown in Table VII and the total weights of marketable heads per light are given in Table VIII.

No large treatment differences appeared in the lettuce crop. The only significant effect ($P=0.05$) was the excess of the middle level of 'Merloam' over the mean of the other two levels (Table VIII). A similar effect in Table VII did not reach significance. The mean number of first grade heads per light; 12.9 out of a possible 24 was not satisfactory. The lack of improved crop performance following applications of peat and 'Merloam' would seem to indicate that neither material effected any particular improvement in a soil which at the outset of the experiment was known to be at a low fertility level.

TABLE VII
Number of first grade heads per light

	Concentration of 'Merloam'			Mean	Unrotivated controls	
	0	0.05%	0.1%		With KNO_3	Without KNO_3
No peat	13.8	14.8	11.4	13.3	14.9	13.2
Peat	12.3	12.9	12.2	12.5		
Mean	13.0	13.8	11.8	12.9		

s.e. for comparison in the body of the table including unrotivated controls

$= \pm 1.30$ (A)

Least significant difference ($P=0.05$) $= \pm 2.8$ (B)

s.e. for comparison of column means

$= \pm 0.921$ (C)

Least significant difference ($P=0.05$) $= \pm 1.976$ (D)

s.e. for comparison of row means

$= \pm 0.752$ (E)

Least significant difference ($P=0.05$) $= \pm 1.613$ (F)

s.e. per plot $= 14.0\%$ of the mean (G)

TABLE VIII

Total weight of marketable heads per light

	Concentration of 'Merloam'			Mean	Unrotavated controls	
	0	0.05%	0.1%		With KNO ₃	Without KNO ₃
No peat	6.59	7.15	5.89	6.54	6.83	6.83
Peat	6.16	6.65	6.39	6.40		
Mean	6.37	6.90	6.14	6.47		

(A) ± 0.473 , (B) ± 1.01 , (C) ± 0.334 , (D) ± 0.72 , (E) ± 0.273 , (F) ± 0.59 ,
 (G) 10.2%. (For key see Table VII.)

First cycle—second crop—self-blanching celery

With the objective of raising the low level of fertility of the soil as evidenced by the poor performance of the lettuce crop, F.Y.M. was forked into the soil at the rate of 40 tons per acre. As far as possible, forking was done to a depth of three inches only. After forking, two ounces per light of a mixed fertiliser (9 : 9 : 15) were broadcast and rotavated in, except on the non-rotavated controls where mixing was done by raking.

Seed of golden self-blanching celery was sown on 1st March, 1953, in sterilised John Innes seed compost in a heated greenhouse. The seedlings were pricked out into lights on 21st April and transplanted into the prepared lights on 22nd and 23rd May, at a spacing of $9 \times 7\frac{1}{2}$ inches. The plants were well grown and well rooted when moved. Shortly after planting out, the plants were badly checked by a high temperature. The ranges were watered twice weekly, this frequency being all that could be accomplished with the available labour. By the 24th June bolting was widespread and it was evident that the crop was going to be most unsatisfactory.

At harvest, 17th–24th August, about 60 per cent. of all plants had run to seed but the remainder had made very good growth and were fit for marketing. The mean weights per plot of all growth are shown in Table IX and they indicate that the treatments had produced no effect on total growth. Further analyses of these total yield figures are not considered to be worth presenting, owing to the large amount of bolting in the crop.

TABLE IX

Self-blanching celery
Mean weight per plot of all growth, lb.

	Concentration of 'Merloam'			Non-rotavated controls	
	0	1	2	A	B
Peat	172.9	162.9	158.4	172.5	170.5
No peat ..	166.5	160.2	162.4		

Although the first cycle of this experiment did not give any indications that the conditioner treatments had been beneficial it was decided to continue the experiment for a further cycle, in view of the unsatisfactory nature of the crops.

Second cycle—first crop—early lettuce

The ranges were cultivated to a depth of three inches after the removal of the celery crop in August 1953. No further manures were applied before plants of lettuce (variety May King) were put out in late November. In spite of the very severe winter nearly all the plants survived and gave a satisfactory crop (80 per cent. good heads) of good quality in the latter half of April 1954. The weights per plot of marketable lettuce are shown in Table X.

TABLE X
Weight per plot of marketable lettuce in tons per acre

	Concentration of 'Merloam'			Mean	Unrotavated controls	
	0	0.05%	0.1%		A	B
No peat ..	11.04	11.35	11.43	11.27	11.70	10.35
Peat ..	11.22	9.97	10.03	10.41		
Mean ..	11.13	10.66	10.73	10.90		

(A) ± 0.645 , (B) ± 1.38 , (C) ± 0.456 , (D) ± 1.05 , (E) ± 0.376 , (F) ± 0.87 , (G) 9.7%.

The better performance of one of the unrotavated controls in this experiment is not readily explicable. Otherwise there would appear to be no consistent trends in the yields from the treated plots.

Second cycle—second crop—self-blanching celery

After removal of the lettuce crop the ranges were dug to a depth of three inches, a difficult operation, after three ounces per light of a compound fertiliser had been broadcast over the ranges. Plants of golden self-blanching celery were raised from seed sown in heat on 2nd April in boxes. The seedlings were pricked out into soil-warmed Dutch lights from 28th April to 5th May, 1954, and the plants were put out in the experimental ranges at a spacing of $9 \times 7\frac{1}{2}$ inches from 8th-10th June, 1954. The plants grew well and produced an excellent crop of good quality with no bolting. A slight attack of leaf spot was controlled by three heavy applications of Bordeaux mixture. Harvesting began on 7th September, 1954, and was completed in about ten days. The mean yields per plot of marketable heads (converted to tons per acre) are shown in Table XI.

TABLE XI
Mean weights per plot of marketable celery in tons per acre

	Concentration of 'Merloam'			Mean	Unrotavated controls	
	0	0.05%	0.10%		A	B
No peat ..	18.8	18.2	19.0	18.7	17.6	18.1
Peat ..	18.1	19.5	17.6	18.4		
Mean ..	18.4	18.9	18.3	18.4		

(A) ± 1.41 , (B) ± 3.0 , (C) ± 0.997 , (D) ± 2.3 , (E) ± 0.822 , (F) ± 1.9 , (G) 6.0%.

The conditioner treatments gave no significant effect on the celery crop.

Effect of 'conditioner' applications on the soil

Soil samples were taken from all plots of the main outdoor experiment about two months after the application of the soil conditioners and were submitted to aggregate analyses by the Yoder wet-sieving technique. The calcium salt of vinyl acetate/maleic anhydride co-polymer ('Merloam'), the soil conditioner used in Phase II of the experiment, had a more pronounced effect on the state of aggregation of the soil than the sodium salt of hydrolysed polyacrylonitrile, the conditioner used in Phase I. The improved state of aggregation was apparent when the soil was examined in the field. The conditioner-treated plots had a much better tilth and the soil surface on these plots remained open after rain or irrigation whereas the soil surface on the untreated plots had a smooth 'panned' appearance. Soil samples were again taken from all plots in August 1954 and submitted to aggregate analyses by the same method as used for the earlier samples. The percentage water-stable aggregates at the beginning of the experiment and after $2\frac{1}{2}$ years in the case of Phase I and after $1\frac{1}{2}$ years in the case of Phase II are given in Table XII.

TABLE XII

*Per cent. water stable aggregates
> 0.5 mm. at various conditioner concentrations*

Date	Conditioner concentration. (I)=irrigated									
	OA	OA(I)	OB	OB(I)	1 (0.025%)	1(I)	2 (0.05%)	2(I)	3 (0.1%)	3(I)
<i>Phase I</i>										
March 1952 (H.P.A.N.)	6	7	—	—	8	7	10	6	14	10
August 1954	1.7	2.2	—	—	1.9	1.9	2.2	3.3	2.4	2.7
<i>Phase II</i>										
March 1953 (Ca V.A.M.A.)	3	2	3	3	25	16	47	29	64	49
August 1954	2.1	2	1.9	1.6	5.4	2.7	5.1	4.0	8.2	5.8

The improvement in the state of aggregation observed after the initial treatment of the soil with the conditioners had completely disappeared in the plots of Phase I of the experiment by August 1954, $2\frac{1}{2}$ years after the initial application. The improvement was still apparent, to a very small extent however, in the plots of Phase II of the experiment $1\frac{1}{2}$ years after the initial treatment. It would seem, therefore, that although a pronounced improvement in structure was produced initially by the soil conditioners, the effect did not persist for more than about two years.

From the practical angle, difficulties were encountered in keeping weed growth under control since only the top three inches of soil could be inverted. In addition, it was found that with continued shallow working, a cultivation 'pan' which impeded drainage and root penetration formed rapidly at a depth of 3-4 inches.

SUMMARY

Two main conclusions may be drawn from the foregoing experiments. The application of the synthetic soil conditioners (1) increased the percentage of water stable aggregates in the treated soil and the increase persisted for a period of about two years, and (2), apart from Experiment 1, Phase I, first cycle, first crop (early peas), gave no appreciable improvement in crop growth. In general, an increase in the percentage of water-stable aggregate in a soil would be considered to be an improvement in the physical condition of that soil and would be expected to result in improved crop performance. The reason for the lack of any such response in these experiments is not clear.

Acknowledgment

Thanks are due to Monsanto Chemicals Limited for providing the soil conditioners and also for carrying out the aggregate analyses.

IRRIGATION REPORT

By E. J. WINTER

To cope with the problem of rain, which has, on occasion, seriously interfered with our irrigation experiments, a number of movable plot shelters were constructed early in 1954. These shelters consist of double-span Dutch lights which run on wheels along the edge of guttering. The guttering serves the dual purpose of providing a rail and a means of running off rain-water. In order to minimise the effect of the glass covers on the growth of experimental crops, the shelters were moved into position over the plots only when there was an immediate threat of rain. Nevertheless it was found that yield of radish and turnips on sheltered plots was less than that on unsheltered plots. The unsheltered plots had received natural rainfall, whereas certain sheltered plots had been given comparable amounts of water by irrigation. Other experiments showed that the effect on yield was not caused by differences between the composition of the rainwater and the irrigation water. It was suspected that variations in intensity of application of the water may have caused the yield differences, and this and other possible causes are under investigation.

During the wet summer of 1954 the plot shelters enabled experiments to be carried out successfully on the effects of different water regimes on some aspects of the growth of peas, lettuce and turnips. Attempts were made to carry out unsheltered experiments on furrow irrigation, and on the influence of irrigation and insecticide on damage caused by cabbage root fly, but the results were vitiated by rainfall. Work was also done with the object of improving various methods of determining the moisture status of the soil. These included the use of instruments for direct measurement of soil moisture conditions and also the methods of Penman (1) and Thornthwaite (2) for calculating soil moisture deficit from meteorological data.

Special attention has been paid to the assessment of quality of vegetables grown in irrigation experiments, using tasting tests and objective determinations. The tests have shown that various irrigation treatments can have either beneficial or detrimental effects on the different quality factors of vegetables.

The effect of different irrigation treatments on the germination of certain vegetable seeds and establishment of the seedlings (Eileen M. Canavan)

Pilot experiments were carried out during the winter in a greenhouse, using vegetable crates as soil containers. Three regimes were established by bringing the soil in different boxes to field capacity at various intervals before a common sowing date.

During the summer, similar treatments were applied to field plots. These were protected from rain by movable shelters (see above). The daily loss of water from the soil (evaporation plus transpiration) was calculated using a method based on Penman's formula (1). The regimes were maintained by watering each plot when its soil moisture deficit reached a certain value. These values were chosen so that watering was required either daily, or about every third day, or about every sixth day.

The results indicated the range within which lay the optimum soil moisture conditions for germination and establishment of peas, lettuce and turnips, but it should be remembered that the weather during 1954 was far from average, e.g. during the experiments the mean soil temperature at a depth of one inch was about 60°F. ; this was five to ten degrees below average. In these experiments the most satisfactory germination and establishment of peas was obtained when the seed was sown two inches deep and the soil was restored to field capacity immediately after sowing, more water being applied whenever the deficit reached 0.40-0.45 inch ; this was about every sixth day. In contrast, turnip and lettuce appeared to require a much wetter regime for optimum germination and establishment, namely a deficit not exceeding 0.25 inch.

In order to maintain this regime, water had to be applied about every third day. Under the conditions of these experiments the best sowing depth for lettuce was found to be about a quarter of an inch.

The effect of different irrigation treatments on yield and quality of summer lettuce (E. J. Winter)

In one experiment the seeds (var. Borough Wonder) were sown on 5th August and pricked out into the field as soon as they were large enough to handle. This method resulted in a very even stand of plants. The plots were allowed to receive rain until the plants were 34 days old, when the leaves were beginning to turn inwards to form hearts. All the plots were then brought to field capacity and the following treatments were begun :—

Treatment A. Restored to field capacity every two days.

Treatment B. Restored to field capacity at a time judged to be midway between the beginning of hearting and harvest.

Treatment C. Not watered.

The regimes were controlled by calculating the theoretical loss of water from the soil by a method based on Penman's formula, and by applying sufficient water at each irrigation to restore to field capacity the depth of soil which had been penetrated by the roots of the crop. After starting the irrigation treatments, the plots were protected from rain by movable shelters.

Some of the results are given in Table I, which shows that the highest yields were obtained in the driest regime, i.e. those plots which were not watered after the beginning of hearting. A number of the plants in the wettest regime (A), watered every second day remained leafy and did not produce solid hearts. The weight of all such unmarketable plants is shown in Table I.

TABLE I

Lettuce

Means of four replicates

Regime	Number of marketable heads (out of 28)	Total weight of marketable heads lb.	Total weight of unmarketable plants lb.
A (wet) ..	17	7.69	1.50
B (medium) ..	18	8.00	1.31
C (dry) ..	21	8.87	0.43
Difference required for significance ($P=0.05$)	5.9	0.62	1.08

Tasting tests carried out on samples of marketable produce from each regime showed distinct differences in flavour and texture, but all were palatable and the tasters were not sufficiently experienced to decide which were best from the point of view of the general public.

Many growers of glasshouse lettuce have found it unnecessary to irrigate between planting out and harvest. The results of this experiment on outdoor lettuce supported this system of growing, and indicated that the roots of the lettuce plant were capable of extending downwards as fast as they depleted the soil of water. Veihmeyer (3), on the other hand, has reported that the roots of lettuce were 'unable to seek out the water, and had to have it brought to them by irrigation'.

The effect of different irrigation treatments on yield and quality of turnips (G. Stanhill)

The object of these experiments was to determine the best watering treatment for the turnip crop. In each experiment seeds of variety White Milan were drilled by hand; the seedlings were thinned to a spacing of ten inches square, and the crop was harvested ten weeks after sowing. The plots were sheltered from rain by movable shelters and variations in soil moisture content were measured on soil samples. The watering treatments were regulated according to the results of these soil moisture determinations.

In the first experiment the treatments were as follows :—

Treatment A. Watered when the soil had dried to permanent wilting point.

Treatment B. Watered when 50 per cent. of available water had been used.

Treatment C. Watered daily.

At each irrigation sufficient water was added to restore to field capacity the depth of soil which had been penetrated by the crop roots.

Some of the results obtained are summarised in Table II.

TABLE II

Turnip—Experiment 1

Means of four replicates

Regime	Mean fresh weight of a single turnip* lb.	Inches of water lost from soil (evapo-transpiration)	Number of applications of water
A (dry) ..	.187	4.2	0
B (medium) ..	.244	4.5	4
C (wet) ..	.301	5.2	46
Difference required for significance ($P=0.05$)	.008	—	—

* As all plots contained the same number of plants and there were no deaths, the mean weight per turnip is also an indication of the total yield.

The plants in the wettest regime (C) produced the highest yield of turnips, the largest total weight of fibrous roots, and the shallowest root systems. Cooked turnips from this regime were softer and more watery, and had less pungent flavour than those from the drier regimes. The least watery and strongest flavoured turnips came from the intermediate regime (B), while the driest regime (A) yielded the toughest roots which were intermediate in wateriness and strength of flavour. Turnips from each regime were stored in potato trays for about eight weeks; those from the wettest regime (C) retained their turgidity longer than those from the drier regimes.

In a second experiment, the dry regime (A) was replaced by one in which the soil was restored to field capacity whenever 25 per cent. of the available water had been lost. The results were partially obscured by a heavy attack of cabbage root fly, but as far as could be ascertained, they supported those of the first experiment.

A third experiment was begun in September, in which all the plots were maintained at field capacity by daily watering, except during certain stages of growth of the plants, as shown below :—

Treatment C. (Control) Maintained at field capacity throughout the experiment.

Treatment F. No water applied from sowing until emergence of the first two true leaves.

Treatment H. No water applied from emergence of first true leaves until the roots began to swell.

Treatment J. No water after the roots began to swell.

Some of the results are summarised in Table III.

TABLE III

Turnip—Experiment 3

Means of four replicates

Regime	Mean fresh weight of a single turnip lb.	Inches of water lost from soil (evapo-transpiration)	Number of applications of water
C. No dry period ..	.054	3.8	63
F. Early dry period ..	.059	2.8	50
H. Intermediate dry period	.069	2.9	41
J. Late dry period ..	.053	2.8	41
Difference required for significance ($P=0.05$)	.005	—	—

The regime with an intermediate dry period (H) gave the largest turnips, although the total amount of water used was approximately the same as in regimes F and J and less than that in regime C. Tasting tests showed that cooked turnips from the regime with a late dry period (J) were tougher, less watery and more strongly flavoured than those from the other regimes.

These experiments showed that moisture regime influenced not only yield and size of turnips, but also their quality.

Field experiments on the evaporation of water (G. Stanhill)

During the summer of 1954, water evaporation losses from free water surfaces, bare soil, and plant-covered soil were measured and compared with the theoretical losses calculated from meteorological data according to the method of Penman.

The measured losses from a free water surface were found to agree closely with the theoretical values. Correlation coefficients for July, August and September were $r = +0.78$, $+0.73$ and $+0.74$ respectively. Discrepancies between observed and theoretical values varied inversely as the mean daily temperature.

The loss of water from bare soil was found to follow an exponential decay curve which was considerably modified by variations in weather, and by differences in soil apparent specific gravity, soil structure and moisture content. It was found that from midsummer onwards the rate of evaporation of water from soil surfaces increased as compared with that from water surfaces exposed to the same weather (4).

Table IV shows a comparison between measured evapo-transpiration from a turnip crop and the theoretical loss calculated by Penman's method, and also by the somewhat simpler method of Thornthwaite. Whereas evapo-transpiration calculated from meteorological data was very similar for both July and August, the actual losses showed considerable differences. Although the crop was well supplied with water and completely covered the ground during both periods, evapo-transpiration was reduced in August and this may have been associated with a reduction in the growth rate at this time.

TABLE IV

Period of comparison (1954)	Total loss of water, in inches, from soil under a turnip crop		
	Measured using oven-dried soil samples	Calculated using Penman's formula	Calculated using Thornthwaite's formula
29th June—27th July ..	4.22	3.00	3.76
1st August—			
1st September	2.92	3.09	3.54

REFERENCES

- (1) PENMAN, H. L. (1948). *Proc. Roy. Soc. A.*, **193**, 120-45.
- (2) THORNTHWAITE, C. W. (1948). *Geogr. Rev.*, **38**, 55-94.
- (3) VEIHMEYER, F. J. and HOLLAND, A. H. (1949). *Bull. Calif. Agric. Exp. Sta.*, 711.
- (4) STANHILL, G. Letter to *Nature, Lond.* (in the press).

ENTOMOLOGY REPORT

By D. W. WRIGHT

The work of the Entomology Section continued during 1953-54 mainly on the lines of previous years. Studies were begun, however, on field populations of the cabbage root fly with a view to determining the effect of predatory and parasitic insects on the abundance of the immature stages of this pest. Preliminary observations were made on the biology and occurrence of the carrot fly on parsnips and on the life cycle and ecology of the lettuce root aphid (*Pemphigus bursarius* L.), prior to carrying out more detailed work in 1955.

Work on insecticidal dusts was temporarily suspended by the absence of Mr. G. A. Wheatley who was awarded a Kellogg Foundation Scholarship to visit the U.S.A.

CABBAGE ROOT FLY (D. W. Wright, Dorothy D. Bowe and J. Buxton)

The damage caused by the cabbage root fly on summer cauliflowers at Wellesbourne in 1954 was very much less than in 1952 and 1953, and only small increases in yield resulted from the use of insecticides to prevent attack. Experiments designed to investigate the effect of earliness of transplanting on infestation and crop loss and on the relative susceptibility to attack of three varieties of early cauliflowers yielded inconclusive results. The former experiment showed however that the earlier the date of transplanting the greater the yield of heads. The variety Finney's 110 transplanted on 23rd March, 2nd April and 12th April yielded 331.9, 298.5 and 248.2 pounds per 256 heads respectively.

The levels of root fly control and the phytotoxic effects given by gamma BHC, aldrin and dieldrin when used in solutions at different concentrations, dosage rates and methods of formulation were further studied in the field. Gamma BHC suspensions when used at 0.04 per cent., i.e. double the recommended concentration, caused stunting of summer cauliflowers especially when applied to plants in pots immediately before setting out. With aldrin there appeared to be a greater margin of safety, for more than twice the recommended concentration was used without causing plant injury. Gamma BHC suspensions, and a suspension and an emulsion of aldrin all gave very high levels of root fly control; dieldrin emulsion however was somewhat less effective.

The insecticidal and phytotoxic effects of dipping the roots of brassica plants at the time of transplanting into solutions containing insecticides were also investigated. Suspensions of aldrin and gamma BHC both gave high levels of root fly control but at concentrations of 0.5 per cent. and above, gamma BHC proved highly phytotoxic. Aldrin at this concentration did not adversely affect growth and also gave a satisfactory root fly control. These results were obtained under cool moist conditions highly suitable for transplanting. With higher temperatures and drier soils phytotoxic effects may well appear at lower concentrations.

The populations of cabbage root fly eggs, larvae and pupae were studied throughout the season on summer and autumn cauliflowers. Half-weekly samples showed that more than 500 eggs may be laid around one plant during its growing period. Although most of these may hatch, only a relatively small percentage of the larvae reach maturity and pupate. Some six species of Coleoptera, some of which are common in the field were found to be predatory on the eggs and larvae.

Yield trials on summer and autumn cauliflowers and on summer cabbage were also carried out at the N.A.A.S. E.H.S., at Efford, Luddington and Stockbridge House. At Luddington, as at Wellesbourne, root fly caused comparatively little damage in 1954. At Stockbridge House, however, the untreated plots of summer cauliflowers and cabbage were severely damaged and insecticidal treatment gave increases in yield, compared with the controls, of 470.5 per cent. and 328.8 per cent. respectively. Less spectacular but very substantial increases also occurred at Efford following the use of insecticides.

THE CONTROL OF CARROT FLY ON CARROTS (D. W. Wright)

Three main problems confront the investigator who is using chemical means for the control of an insect pest. Firstly the method must give a high level of pest control, secondly the method must be acceptable to the grower on economic and practical grounds, and thirdly the quality of the produce must not be adversely affected by the chemical used. In the control of the carrot fly on carrots these three requirements have proved very difficult to combine. The most effective insecticide for this pest so far tested is gamma BHC and, when used as a seed dressing, treatment is both inexpensive and easy to carry out. Its use in this way, however, suffers from the very serious defect that the dosage rates of insecticide required to give a high level of carrot fly control may also cause either loss of flavour or off-flavour (tainting) in the carrots after cooking. This has occurred with disturbing regularity with main-crop and late carrots grown at Wellesbourne in 1953 and 1954. Of six samples canned from these crops five possessed distinctly fusty flavours. In each case the seed had been treated with dressings containing gamma BHC of high purity (lindane quality) and at rates varying from $1\frac{1}{2}$ to 2 ounces of a 50 per cent. gamma BHC dressing per pound of seed. On light soils in East Anglia similar levels of gamma BHC seed dressings have also resulted in tainting of the crop. With gamma BHC of somewhat lower purity severe tainting has occurred at a rate of 1 ounce of a 50 per cent. dressing per pound of seed.

Although the tainting or loss in flavour may be most apparent after canning, tasting tests at Wellesbourne have shown that similar changes in flavour can be detected in carrots cooked in ordinary kitchen utensils.

The capacity of gamma BHC to affect the flavour of carrot crops appears to be much less on soils of high organic content (e.g. fen soils) than on soils where this is low. With main-crop carrots grown on light or medium loam soils for canning or processing, evidence indicates that it is unwise to apply gamma BHC to the seed at a rate greater than 1 ounce of a 50 per cent. dressing (or the equivalent) per pound of seed. Even this rate may lead to loss of flavour with carrots which have a relatively short growing period, such as the early or the late-sown crops.

Tasting tests on main-crop carrots grown on fen soils in East Anglia have shown that no tainting of the crop occurred where the seed had been treated with $1\frac{1}{2}$ ounces or less of 50 per cent. gamma BHC dressing per pound of seed. With late (June)-sown carrots, which have a shorter growing period than the main crop, this dosage rate has caused loss of flavour. With a dressing rate of 1 ounce of this material per pound of seed, however, there would appear to be little danger of tainting this crop on fen soils. Less information is available concerning the dosage rates which can be safely used on the early-sown crop on fen soils. If these are to be lifted early—in July or early August—then it would appear unsafe to use a dosage rate greater than that suggested for the late-sown crop, i.e., 1 ounce per pound of seed.

The levels of gamma BHC seed dressings suggested above as being unlikely to cause taints are not usually sufficient, however, to give a good commercial control of the pest. Supplementary spraying treatment of the growing crop is therefore required, especially in areas where infestations are normally high. Field experiments at both Wellesbourne and on fen soil at Chatteris (Isle of Ely) have shown that sprays containing dieldrin will considerably increase the level of control. On main-crop and late-sown carrots many combinations of spray treatment have been tested, varying both the rates of spray application, the concentration of insecticide in the spray and the time of spraying the crop. The best results were obtained by spraying twice, first in mid-August and again in early September, using 50 to 75 gallons of spray per acre, the spray containing 0.1 per cent. dieldrin. Carrots taken from crops sprayed twice in this way were not found to be tainted.

Field experiments have also been carried out to compare the effectiveness of aldrin and dieldrin seed dressings with those of gamma BHC. At both Wellesbourne and Chatteris, aldrin was much the least effective of the three materials and gave a poor control even when used at dosage rates as high as 8 ounces of the 50 per cent. dressing per pound of seed. Dieldrin seed dressings also proved less effective than those of gamma BHC on fen soils at Chatteris. At Wellesbourne, however, when used at a

dosage rate of 2 ounces of the 50 per cent. dieldrin per pound of seed, results equal to those given by gamma BHC, used at a similar rate, were obtained. With higher dressing rates little benefit resulted from the use of the additional dieldrin. Canning and tasting tests showed that no tainting occurred where dieldrin had been used on the seed. If these results are confirmed by further field experiments then dieldrin seed treatments are to be preferred to those of gamma BHC for carrots grown on light or medium loam soils especially where the infestations encountered are not liable to be severe.

THE CONTROL OF CARROT FLY ON PARSLEY (D. W. Wright)

Although carrot fly has long been known to cause damage to parsley very few attempts have been made to control it on this crop by insecticides. Attention was drawn to the problem in Scotland, where it was reported to be causing severe losses, many field crops of parsley having been destroyed by the pest. Because of the similarity in mode of attack of the carrot fly on parsley and on carrots, treatment of parsley seed with a 50 per cent. gamma BHC dust was tried as a means of controlling the insect. In 1953 a few rows of parsley were drilled across a field at Musselburgh using seed treated with the BHC dressing at the rates of 2 and 4 ounces per pound of seed. The remainder of the field was drilled with untreated seed. A severe carrot-fly attack followed causing considerable damage to the crop except where the seed dressings had been used. In the autumn the treated rows were reported to be thick and vigorous and to be practically the only usable rows in the field. With both rates of seed dressing the crop was similar in appearance.

In 1954 a replicated experiment was carried out in a field in the same locality. Parsley seed was treated with a 50 per cent. gamma BHC dressing at the rates of 1, 1½ and 2 ounces per pound of seed and sown in March. Examination of the plots in July showed that the carrot fly had caused severe damage on the untreated plots where most of the plants were stunted and showed much yellowing of the foliage. On the treated plots the foliage was vigorous and a full green colour, as it was on the parsley crop on the remainder of the field which had also been grown from seed treated with gamma BHC. Plant samples showed that on the untreated plots the tap and fibrous roots had been extensively damaged by the larvae of the carrot fly and many showed signs of rotting. On the treated plots both forms of damage were slight but were somewhat higher on the plots which had received treatment at the rate of 1 ounce per pound of seed than on those treated at the higher rates. This observation together with experience based on the persistence of similar seed dressings on carrots suggests that the 1 ounce rate may well give inadequate protection to the crop over a long growing period. A rate of 1½ ounces of the 50 per cent. gamma BHC dressing per pound of seed would, therefore, be a preferable recommendation. Furthermore, for parsley grown on soils of high organic content (e.g. fen soils) an even higher rate of seed dressing may be necessary to give adequate protection against this pest.

CARROT FLY ON PARSNIPS (J. A. Hardman and G. A. Wheatley)

The larva of the carrot fly is also a serious pest of parsnips and has been thought to be associated with the canker disorder of this crop. Control measures for the pest are not economically possible at present and a programme is to be pursued during 1954-55 to study the problem.

To provide some background for this work, observations were made during the year on the biology of the carrot fly (*Psila rosae* F.) attacking parsnips on the Station. Larvae and pupae taken from parsnips were found to be rather smaller (by about 0.5 mm.) than those obtained from neighbouring carrots. The habits of the larvae also appeared to be different in parsnips from those found in carrots. In parsnips the mines were deeper and some penetrated almost diametrically through the crown of the root; in carrots, the mines were confined almost entirely to the outer cortex of the root.

NATURAL CONTROL OF APHID POPULATIONS (J. A. Dunn)

Further studies on the populations of the pea aphid on lucerne and on peas were carried out in 1954. Although the fundatrix population on lucerne in the spring was small, the crop became heavily infested by mid-July in spite of low temperatures and much rain during the early summer. Predators were then almost absent, the low temperatures probably having had a greater adverse effect on their activity and reproduction than on the aphids'. The incidence of parasitism, however, was nearly 20 per cent., and the inclement weather, by preventing flight of the parasites may well have increased their efficiency by restraining them from leaving the proximity of their aphid hosts. Conditions for migration of the winged aphids in late spring were very poor and of those which succeeded in reaching the pea crop, very few established colonies.

Further information was obtained on the feeding and development rates of the predators of the pea aphid, especially as influenced by temperature.

LETTUCE ROOT APHID (J. A. Dunn)

Observations were begun during the summer on the biology and incidence of lettuce root aphid. The numbers of aphids found on the roots of summer lettuce grown on plots maintained at different moisture levels showed no correlation with the water content of the soil. Similarly, there were no significant differences in root infestation between five varieties of cabbage lettuce. In both sets of observations, however, the populations of aphids were low.

The roots of certain weeds, recorded in the literature as alternative hosts of the lettuce root aphid were examined, and in autumn many were found to be supporting large colonies of aphids.

PEA MOTH (J. A. Dunn, G. A. Wheatley and D. W. Wright)

Further information was obtained on the effect of temperature on the rate of development of the pea moth, with a view to predicting the time of emergence of the moths in early summer. Larvae were collected from different sources in Lincolnshire, Essex and Bedfordshire and it was found that, under constant temperature conditions, the time taken for development to the adult stage varied with the source. Knowing the temperature characteristics of the material from each source, it was found that, by taking continuous temperature records, the time taken to give emergence of the moths could be predicted with considerable accuracy under the fluctuating temperature conditions of an unheated glasshouse and of field plots.

With continuous-recording thermometers, data were obtained on the temperature of the soil during winter, spring and early summer on two field plots, one carrying winter wheat and the other kept free of vegetation. Despite the wet period in the late spring the rate of temperature accumulation in bare soil, as anticipated, was more rapid than in soil carrying a crop. Emergence of the moths began seven days earlier on the bare ground than on that covered by the cereal crop. Furthermore, they emerged from each plot when the accumulation of effective temperatures had reached the same point, which was also the value expected from the laboratory studies. In a dry and sunny season the difference between the bare and covered soil would be even greater. Such variations in the rate of heating up of the soil in early summer may well cause differences of two or more weeks in the time of emergence of the moths from land carrying a full covering crop as compared with land with much of the surface bare (e.g. root crops). The flight period of the moths in any area, therefore, may be expected to be much longer than emergence records from one site would suggest.

Acknowledgments

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Rickwood, Chatteris and Mr. F. Garner, Manager of Messrs. F. Hiam Ltd., Cambridge, the N.A.A.S. E.H.S. at Efford, Luddington and Stockbridge House and the members of the N.A.A.S. staffs at Cambridge and Kirton. They are also much indebted to the Fruit and Vegetable Canning and Quick Freezing Research Association, Chipping Campden, for carrying out canning and tasting tests.

In connection with the visit of Mr. G. A. Wheatley to the U.S.A. appreciation is expressed to the Director and Board of Control of the Connecticut Agricultural Experiment Station for the many facilities provided and to Mr. Neeley Turner and the staff of the Entomology Department for the considerable interest and kindness shown.

PLANT PATHOLOGY REPORT

By W. G. KEYWORTH

During 1953-54 research has continued on most of the projects described in the last Annual Report. Further progress reports are given below.

As a preliminary step in the study of parsnip canker, attempts to control carrot fly infestation in the experimental plots have been continued. Very frequent applications of dieldrin accomplished this and the treatment has enabled experiments to be started on canker uncomplicated by carrot fly damage.

A new project is the study of mint rust which is a serious problem in outdoor plantings of garden mint (*Mentha spicata*). Preliminary tests have been made of heat treatment of the cuttings before planting. A collection of mint varieties has also been started to provide material for resistance trials.

The co-operation of the Royal Horticultural Society in the collection of mint varieties is gratefully acknowledged. Thanks are also due to many growers who have given facilities for observations and experiments on their farms on many projects, and to officers of the N.A.A.S.

CROOK ROOT OF WATERCRESS (J. A. Tomlinson)

Studies on the disease have continued on similar lines to those described in the previous Annual Report, viz. (i) surveys of commercial beds, and (ii) laboratory studies on waters of special interest. Attempts have been made to correlate the results obtained under the two sets of conditions and, in particular, to reproduce in the laboratory the water conditions which are associated with the suppression of the disease in some commercial beds.

Disease assessments have been made in commercial beds with special reference to the presence of crook root in parts of the beds at varying distances from the primary and supplementary water sources. In addition to the seasonal differences previously observed, these assessments have now shown that the amount of infection is closely correlated with the distance of the cress from the water supply. Thus, near the water source, the plants are not only vigorous but their roots show very little infection. Some factors, therefore, associated with the proximity of fresh water tend to reduce the amount of infection. Experiments on the various factors which might produce this effect (rate of water flow, chemical constitution and gas content of the water, etc.) are in progress.

Suppression of infection (as distinct from an increase in plant vigour) has also been obtained in the laboratory when using a local river water, but heat treatment of this water by boiling or autoclaving has been found to remove the factor inhibiting infection. Analyses of the autoclaved and un-autoclaved water showed that the former contained less iron, phosphate and calcium bicarbonate than the latter.

In view of this result, and the fact that in commercial beds the severely diseased plants sometimes showed mineral deficiency symptoms, laboratory tests were made to determine whether the addition of iron or phosphate to the test waters would cause suppression of infection. With concentrations similar to those in the un-autoclaved waters, however, no reduction of infection occurred. A parallel test in commercial watercress beds in which trace elements were added in the form of glass 'frits' (1) also gave no observable reduction in the disease. The tests are not yet complete but it seems likely that the iron and phosphate constituents of natural waters (and possibly other minor elements) do not play an important role in the suppression of the disease.

The significance of the calcium bicarbonate content of the water in relation to infection is still being investigated and the possible effects of this substance and related water constituents are not yet clear. It can be reported, however, that the re-solution of the precipitate obtained by autoclaving the river water caused a considerable reduction in root infection. This demonstrates that the compounds responsible for the suppression of infection in the river water are among those precipitated by heat.

VIRUS DISEASES OF WATERCRESS (J. A. Tomlinson)

Surveys during the summer showed that virus-like symptoms occurred on plants in many commercial beds in several counties. Symptoms occurred on many plants in some beds, but on a few plants only in others. These symptoms varied considerably but usually consisted of a few to many, small or large, light green or yellowish leaf spots in the form of a mottle. Occasionally a mild or pronounced, yellow-green mosaic, and yellowish or purplish ring spotting were found. The symptoms have been reproduced on healthy watercress by sap inoculation and by means of the aphid *Myzus persicae*. It thus appears that they are of virus origin. Mechanical transmissions have also been made from infected watercress to tobacco seedlings which developed necrotic local lesions; also to *Nicotiana glutinosa*, turnip, radish, annual stock (*Mathiola incana* var. *annua*) and several cruciferous weeds.

Further work on the host range and identity of the viruses collected and on the effect they produce on the growth of watercress is in progress.

SILVERING DISEASE OF RED BEET (W. G. Keyworth and J. Sheila Howell)

Causal organism. Further studies on this disease have shown it to be caused by a bacterium, not by a virus as suggested in the previous Annual Report. The bacterial nature of the disease was not determined until late 1954, however, and thus most of the transmission experiments have been made with infected sap using techniques applicable to virus diseases.

The bacterial pathogen is gram-positive and from its cultural characters and morphology it can be classified as a species of *Corynebacterium*. This diagnosis has been confirmed by Dr. W. J. Dowson of Cambridge. The pathogen has been consistently isolated both from roots and from leaves of affected plants growing in several widely separated localities. When inoculated into healthy leaves of Cheltenham Green Top beet it gave rise to typical lesions of a silvery appearance and was re-isolated from such lesions. It has also been inoculated into the tap-roots, causing the characteristic systemic symptoms (silvering of the veins and lamina).

Seed transmission. The experiment on seed transmission briefly described in the 1953 Report was continued in 1954. Approximately 1000 plants were raised in the open from 'silvered' seed (collected from infected seed plants in 1952) and 1600 from 'healthy' seed (collected from apparently healthy plants in 1952). 50 per cent. of the plants from silvered seed had shown infection by mid-June 1954 compared with 9 per cent. of those from 'healthy' seed. Four fifths of the infected plants in the 'healthy' group occurred in one plot and had probably contracted the disease from nearby silvered plants.

This and previous experiments show that the disease is certainly seedborne. The percentage of seeds from an infected plant which carry the disease is unknown but the experiments suggest that it may be relatively small (i.e. less than 5 per cent.). The plants from such infected seeds constitute disease foci from which the disease may spread, to give outbreaks of considerable extent.

Field transmission. Inspections of commercial plantings were made from May 1954 onwards. By early May (seven weeks after planting out from the steckling bed) some fields showed up to 37 per cent. of disease and the crops in these fields eventually became almost a total loss. The infected plants were frequently in 'runs' of up to six plants in a row. It is thought that these plants had occurred together in the steckling bed and had thus been planted adjacently. An unused steckling bed was inspected and found to contain many patches of infected plants.

These and other observations suggest that the major spread of the disease occurs in the steckling bed from 'seed infection foci'. Control of the disease thus seems most likely to be achieved by eliminating seedborne infection or, if this is not possible, by reducing the subsequent spread in the steckling bed. Tests are now in progress on these two possibilities.

Experimental transmission. The disease has been found to be readily transmitted from root to root by cutting with a knife. It is thus apparent that the making of inspection cuts in selecting roots for stock seed production may transmit silvering. The disease has frequently been transmitted by the insertion of portions of affected roots into healthy roots. Transmission to healthy roots also occurred if these were bitten by rabbits which had fed on diseased roots immediately beforehand.

Leaf symptoms similar to those caused by the bacterial inoculations described above have been induced by rubbing the leaves with sap expressed from infected roots or from severely affected leaves.

A small test of whether the disease could be transmitted by the 'topping' of the main stems in the summer gave a negative result. This possibility cannot be ruled out however.

Numerous tests have been made to determine whether slugs or any of several species of sucking and biting insects found on beet could transmit the disease. All gave negative results.

STEM AND FRUIT ROT OF OUTDOOR TOMATO (D. E. Fisher and J. M. Way)

Studies on this disease have continued on the same lines as indicated in the previous Annual Report. Further field surveys have been made and information obtained on the spread of the disease, which was particularly extensive in some holdings, possibly because of the cold wet growing season.

Seed infection. In one experiment made during 1954, of 50 plants grown from seed taken from infected fruits, 42 per cent. developed the disease, compared with only 8 per cent. of the controls.

Observations in 1953 showed that the pathogen (*Didymella lycopersici* Kleb.) was carried beneath the seed coat and special attention has been paid, therefore, to the possibility of controlling it by heat treatment. These studies have shown that treatment with hot water may be of doubtful value since the thermal death point of the seed is only a little greater than that of the fungus. The seeds are somewhat more tolerant of dry heat, however, and tests are now in progress to determine whether this could give a practical control.

Sterilisation of canes. A second series of tests has shown that either of two treatments will effectively rid the canes of infection :

(i) immersing the canes in 2 per cent. formalin* for 24 hours.

or (ii) immersing for 15 minutes in 5 per cent. formalin* and then keeping wrapped in sacks for one week to allow the fumes to continue to act on the canes.

The latter method has the advantage that a large number of canes can be treated in the same bath in a relatively short time. After the treatment is completed, in both cases the canes should be exposed to the air for at least one week before use.

Soil contamination. Tests have been made of the carry-over of the disease on old infected haulm or fruit dug into the soil in the autumn of 1953. Heavy infection resulted in both cases, 30 per cent. of the plants contracting disease from the buried haulm and 54 per cent. from the fruit. The control treatments in these tests had 2 per cent. and 12 per cent. infection, respectively. It is apparent that as much plant debris as possible should be removed from the sites of outbreaks, and that ground where such outbreaks have occurred in the previous season should be avoided.

Strains of the pathogen. 56 isolates have been obtained from cankers on stems and from fruit lesions. The cultural characters of these isolates are being studied and, in the meantime, tests have been made of their pathogenicity to both stems and fruits. 45 of the isolates attacked stems and fruits. Eight fruit isolates and three stem isolates (which were superficially similar in cultural characters to most of the other isolates) were incapable of re-infecting stems.

The perithecial stage of the pathogen has been found on old infected haulm on one holding. Single ascospore cultures are now being obtained in an attempt to study the natural variation occurring in the fungus.

*Note : The liquid as bought (40 per cent. formaldehyde) should be diluted respectively 1/50 or 1/20 to give the requisite concentration.

Tests for resistance. Tests of the resistance of a wide range of tomato varieties and related *Lycopersicum* species have been made by direct stem inoculation. None of the plants showed any resistance to this type of attack. They include *Lycopersicum glandulosum*, *L. hirsutum*, *L. peruvianum*, *L. pimpinellifolium*, *L. pissisi*, and 36 varieties of *L. esculentum* from British and foreign sources.

RHUBARB VIRUSES (A. G. Channon)

Symptoms of a virus-like nature have frequently been reported from commercial rhubarb plantations. A study of the causes of these symptoms and whether they are associated with any adverse effects upon plant vigour and yield, has now been started. Liaison is being maintained with the N.A.A.S. E.H.S., Stockbridge House, Cawood, Yorkshire, where experiments on rhubarb are being carried out. Visits have also been paid to commercial plantings in Yorkshire, Derbyshire and Essex to study the symptoms most frequently occurring and to collect specimens for experimental work.

The most common symptoms are ringspots of variable size, from 2 to 10 mm. diameter, which sometimes coalesce to produce a mottled effect. It seems likely that all such ringspots may have a common cause. Other symptoms noted are as follows :

- (a) bright yellow flecks,
- (b) yellow mosaic,
- (c) general yellowish chlorosis,
- (d) scattered light green patches.

Symptoms were seen on expanded leaves quite soon after the plants had begun to produce foliage in March, and increased in intensity during spring and early summer. There was a gradual decrease in intensity towards autumn, though a few leaves still showed symptoms in September.

Groups of plants showing two distinct types of symptom were selected for transmission studies. These symptoms were :—

(i) ringspots and (ii) yellow flecks. In both cases sap inoculations to a range of test plants were attempted in order to characterise the viruses and determine their relationship, if any, to other known viruses. The methods used were similar to those described by Yale and Vaughan (2).

(i) *Ringspots.* Inoculations of tobacco leaves with sap from ringspot rhubarb leaves gave necrotic spots on inoculated leaves. This result was obtained many times and successful re-transmissions were made to other tobacco plants. Symptoms were also obtained by inoculation to zinnia, ten week stock and turnip. In addition, direct transmission to healthy rhubarb seedlings resulted in the production of ringspots. It seems most likely therefore that the ringspots on rhubarb were due to virus infection, although it is not yet known whether the virus is related to other known viruses.

(ii) *Yellow flecks.* Inoculations of tobacco with sap from yellow fleck leaves gave very characteristic single or concentric ringspots which closely resembled those caused by the tobacco ringspot virus. These symptoms were entirely different from those produced by the virus from a ringspot rhubarb. Transmissions were also obtained to broad bean on which a pattern of chlorotic rings and lines appeared. Symptoms were also produced on zinnia, dock (*Rumex crispus*) and black bindweed (*Polygonum convolvulus*). It was not possible, however, to reproduce the yellow fleck symptom on healthy rhubarb. It appears, therefore, that the yellow fleck plants contained a sap-transmissible virus but it is not yet certain whether this was causing the yellow fleck symptoms.

It has thus been shown that at least two distinct viruses occur in rhubarb. They can be distinguished by their effects on tobacco and other indicator plants. Further studies are in progress to determine the effects of these viruses on the vigour of rhubarb and to ascertain whether other viruses exist in this crop.

REFERENCES

- (1) WYND, F. L. (1951). Availability to wheat plants of iron in very insoluble glass frits. *Lloydia*, **14**, 1-57.
- (2) YALE, J. W. and VAUGHAN, E. K. (1954). Ringspot-like virosis of rhubarb. *Phytopathology*, **44**, 118-22.

WEED INVESTIGATIONS

By H. A. ROBERTS

Ecology (Marion E. Smart and H. A. Roberts)

In the autumn of 1953, three long-term manurial and cultivation experiments were begun by the Chemistry section and are described elsewhere in this Report. In addition to their primary objects, these experiments presented an opportunity for obtaining information of practical importance about the effects of various cultural sequences on the weed flora. Because they involve a rotation of several different crops with appropriate surface cultivations, it is difficult to make quantitative measurements of weed abundance and distribution on emerged vegetation. It was decided, therefore, to obtain an estimate of potential infestation by assessing the population of viable weed seeds present in the top six inches of soil. This is accomplished by taking core samples which are then subjected to conditions suitable for germination over a period of at least two years, and identifying and recording seedlings as they appear. The first samples were taken before the initial cultivations were carried out in order to determine the original pattern of distribution, and subsequent sampling will be done annually. In this way it is hoped that changes in species composition will be followed and treatment effects on depletion of the existing population determined.

Studies on the dormancy and viability of seeds of some important annual weeds of vegetable crops have been continued. Further data have also been obtained on the period of time required by these species for completion of the life cycle and on the seasonal periodicity of germination in the field.

Chemical control (H. A. Roberts)

Further trials have been carried out to determine the suitability of the herbicide CMU (3-(p-chlorophenyl)-1, 1-dimethylurea) for use as a residual pre-emergence treatment in vegetable crops. As in the 1953 experiments, a range of dose rates was used, the volume was maintained at 100 gallons per acre, and the treatments applied before emergence of the crops and weeds.

Determinations of the relative susceptibility of annual weeds to CMU were in good agreement with those of previous years and in an experiment with ten vegetable crops it was again found that lettuce, radish and onion were the most susceptible while carrot and beet were among the more tolerant. In 1954, however, the dose level required to produce a given degree of crop injury was lower than that of the two previous seasons in which CMU has been under trial. This occurred in a series of seven yield trials with various clean crops, and also in yield trials with beet and peas conducted at Efford and Stockbridge House E.H.S. A rate of $\frac{1}{2}$ lb. of CMU per acre, which was the minimum required for good control of mixed populations of annual weeds, resulted in appreciable decreases in the yield of marketable produce in experiments with beet, carrots, peas and other crops.

It appears that the higher rainfall during these experiments was the probable reason for the greater toxic effects. Rainfall is known to be an important factor in the action of CMU, and this has been shown previously with onions (1). Nevertheless, the earlier work did suggest that CMU was sufficiently promising to merit further testing. The 1954 experiments have now shown that under some rainfall conditions the selectivity is not great enough to permit use with any of the annual vegetable crops and this, in conjunction with the complicating influence of soil organic matter content on residual action, indicates that further work on these lines is unlikely to have practical value.

One possible application of CMU is for the control of certain weeds in established asparagus. It is used extensively for this purpose in the U.S.A. and preliminary trials at the N.V.R.S. have given encouraging results.

Two analogues of CMU, 3-phenyl-1, 1-dimethylurea and 3- (3, 4-dichlorophenyl)-1, 1-dimethylurea were included in some of the 1954 experiments. These compounds differ from CMU in solubility and in the length of time for which they persist in soil, and some differences in relative effects on weed and crop species were found.

Further testing of pentachlorophenol in oil/water emulsion as a contact pre-emergence herbicide has confirmed previous findings. A range of dose rates was applied immediately after sowing various vegetable crops to determine whether there was any residual effect which could injure the seedlings on emergence. Such effects were negligible, and were absent also in a yield trial with lettuce. In an experiment with onions the treatments coincided with a long period of cool weather with no rainfall, and in this instance there was a slight effect on final stand and yield, due to the herbicide persisting as a concentrated layer on the soil surface and causing contact injury to the 'loop' on emergence. In general, however, this herbicide appears to be safe and effective if used at the correct time. With all crops except spring-sown onions it would probably be necessary to prepare the seedbed in advance to allow time for the initial flush of weed seedlings to appear, to drill into the weedy seedbed and then to spray before crop emergence. Such a technique would ensure a clean stand during the early life of the crop and greatly reduce the need for hand-weeding. It is proposed to investigate certain aspects of the method on a wider scale.

Acknowledgment

Thanks are due to the Directors and staffs of the N.A.A.S. Experimental Horticulture Stations at Efford and Stockbridge House for their co-operation.

REFERENCE

- (1) ROBERTS, H. A. (1953). Weed investigations. *Ann. Rep. Nat. Veg. Res. Stn.*, 1952, 41-2.

STATISTICS REPORT

By J. A. NELDER

The Statistics Section has continued to assist other sections of the Station in the design and analysis of experiments. Two aspects of experimentation are being investigated in the Section, namely spacings experiments and the efficiency of field experiments in general. Work on these is described below.

Spacing experiments (J. A. Nelder)

The alteration of the spacing of a crop involves the simultaneous alteration of many other factors in the culture of that crop. These include the nutrient requirements, type of cultivation, size grades in the mature crop, labour costs and so on. The determination of an optimum spacing must take these factors into account. With the co-operation of the Directors of the N.A.A.S. E.H.S., data have been collected on the costs, yields and market returns of lettuce and self-blanching celery, grown at different spacings. Preliminary analysis of the lettuce data shows an optimum spacing for lettuce rather closer than that normally employed. It is hoped to publish a paper on this subject shortly.

Field experimental technique (D. Cooke)

Three experiments under this heading have been completed during the year, one each on spring cabbage, lettuce under Dutch lights and peas. The general idea behind these experiments was given in the 1953 Annual Report, as being that of trying to discover methods of improving the efficiency of field experiments with vegetables. The spring cabbage experiment compared the use of pots with transplanting in frames and leaving plants in the seed bed; the value of the results was seriously reduced by a heavy attack of *Botrytis* in the mature crop. The treatments in the lettuce experiment concerned handling up to the planting-out stage, comparing pricking out with thinning in the seed bed and with planting out directly at the two-leaf stage. The layout and methods of analysis to be used in this type of experiment are still being developed and the past year's trials can only be regarded as preliminary studies. They have brought out, however, the great effect on experimental error of even a small proportion of missing plants in well-spaced crops like the brassicas and lettuce. The experiment on peas was principally designed to test the efficacy of hand sowing against a marked rule as compared with two standard types of drill. The criterion used for comparing the treatments was cost to achieve a given accuracy, the latter being measured by the square of the percentage standard error. Using the weight of marketable pods as the variable, the cost for a given accuracy for hand sowing was 29.8 and 57.0 per cent. of that for the two types of drilling. The results seem promising and further work will be undertaken.

Polygenic variation (J. A. Nelder)

Parent, F_1 , F_2 and backcross populations from four varieties of French bean have been grown to provide material for the study of polygenic variation. The difficult growing season unfortunately increased the non-genetical variability in flowering time, one of the characters being studied, thus making the genetical analysis less precise than might have been expected.

Work for other bodies (J.A. Nelder and D. Cooke)

The section has again been represented on the Bulbs, Flowers, Glasshouse, and Protected Cropping Working Parties of the Agricultural Improvement Council's Experimental Horticulture Committee, to advise on the design of certain experiments at the N.A.A.S. E.H.S.

Layouts for some 29 experiments for outside bodies, involving about 900 plots were prepared during the year, and the analyses of 16 of these, involving about 400 plots, have been completed. The bodies involved included the N.A.A.S. E.H.S., at Luddington, Stockbridge House, Efford and Fairfield and the Experimental Horticulture Committees of the South-Eastern and Eastern provinces of the N.A.A.S.

THE WEATHER DURING 1954

RECORDS OF THE N.V.R.S. CROP WEATHER STATION

By JOSEPHINE I. E. RUBIO, E. J. WINTER and G. STANHILL

Records of the various weather factors made between 1st October, 1953 and 31st December, 1954 are summarised in Fig. 1.

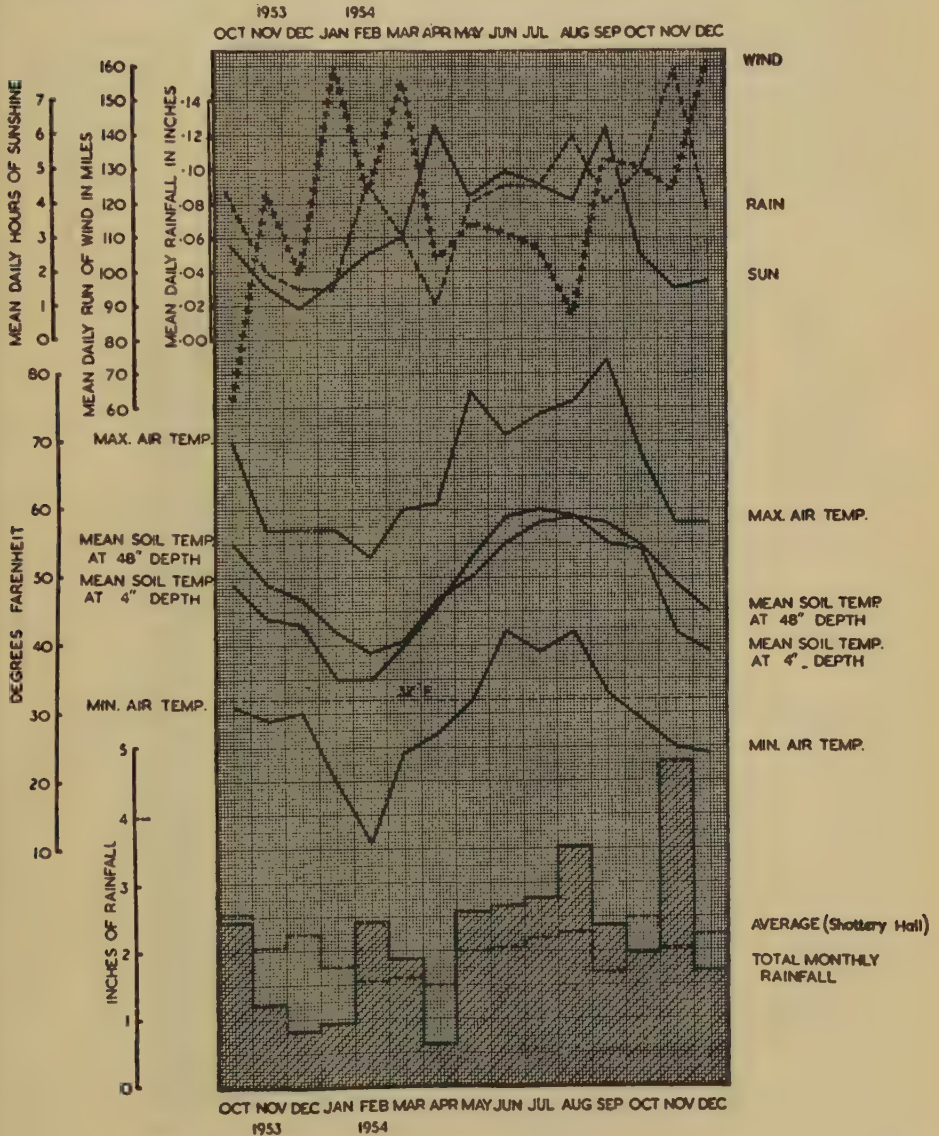


Fig. 1. The weather at Wellesbourne

1954 will long be remembered for its inclement weather. Nevertheless the total rainfall at Wellesbourne during the year was only four inches more than average, namely 29.59 inches. The rainfall during November was about twice the average

quantity for that month, but the January, April and December totals were considerably less than the average. In April there were only eight wet days, and that month was the sunniest of the year, with a daily average of 6.3 hours of bright sunshine.

During the winter of 1953-54, ground frosts were recorded on 108 nights and air frosts on 65 nights. The most severe air frost was on 2nd February when there were 21 degrees of frost. The first air frost occurred on 5th October and the last on 8th May, 1954.

The windiest day in 1954 was 15th January (run-of-wind 388 miles in 24 hours) and the calmest was 19th November (9 miles). The run-of-wind exceeded 300 miles on five days, while the daily average for the whole year was 126 miles.

Meteorological data have been used to calculate the theoretical moisture status of a soil completely covered by a green crop which was supplied with sufficient water to meet its maximum requirement (Fig. 2). In practice, however, shortage of water would have limited evapo-transpiration at some intermediate stage, and would have prevented the establishment of the largest deficits shown. Nevertheless, the graph does show the amounts of water which would have been required to maintain field capacity in a soil covered by a green crop.

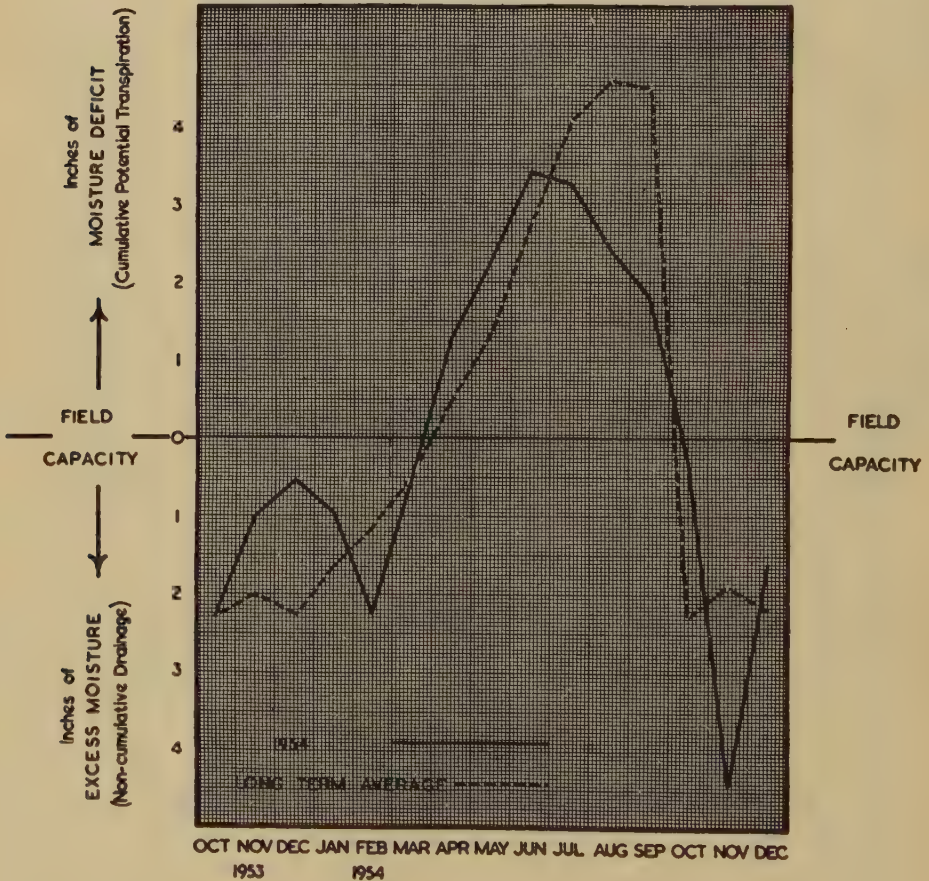


Fig. 2. Theoretical moisture status of a soil at Wellesbourne completely covered with a green crop. The values shown are monthly averages, and the graph is unsuitable for interpolation to obtain intermediate values. The long-term average values were calculated from data obtained from the Meteorological Office.

Low rainfall during January, coupled with favourable conditions for evaporation in the spring (namely high temperature and large amounts of wind and sunshine) caused a deficit to be built up earlier than in an average year. From June onwards, owing to excess rain, low temperature, and poor sunshine, the deficit became progressively less instead of rising to a peak in September as would be expected in a year of average weather.

Fig. 2 also shows that drainage during the winter of 1953-54 was less than average, but in February and November 1954 there was excessive drainage with the consequent risk of leaching of nutrients.

From the grower's point of view, the weather during the spring of 1954 was helpful to most operations. During the summer, however, growing conditions deteriorated and many crops failed to mature properly. The waterlogged condition of the soil seriously interfered with autumn preparations for the 1955 crops, and commencement of ploughing generally was delayed until the dry period in December.

LIBRARY REPORT

By PAMELA SCARBOROUGH, CHRISTINE M. ROWE and H. A. ROBERTS

Development

A nucleus of material, including several long runs of periodicals, was inherited from the Cambridge Horticultural Research Station and transferred to Wellesbourne in the autumn of 1951. Classification was begun under the supervision of Mr. E. J. Winter, subscriptions to periodicals taken out and reference works acquired. As the Station expanded, increased use was made of the Library, and in 1953 and 1954 further books and periodicals were obtained to meet the needs of the various sections. Classification has now been completed up to date and transfer from a room in one of the wooden huts to a larger room in the temporary laboratory block occurred in July 1954.

Present position

Holdings of the main categories of material on 30th September, 1954, are as follows :—

Current periodicals	..	..	..	..	109
Bound periodical volumes	..	..	..	..	215
Current annual reports	..	..	..	..	57
Books and reference works	..	..	..	..	234
Separates	..	..	..	..	1,480
Items in miscellaneous series	..	..	..	..	488

Among the periodicals are general horticultural and agricultural journals, specialist journals relating to the various fields covered by the work of the Station and abstracting and bibliographical publications which permit other current work to be located. Nearly half the periodicals are presented to the Library or are obtained in exchange for the N.V.R.S. Annual Report. Good progress has been made during the year in binding back numbers of periodicals. The annual reports are mainly those of other research stations and are obtained by exchange. Under the term 'separates' are included reprints and circulars or bulletins not taken as series, and these are filed and indexed according to the Universal Decimal Classification. Other publications issued at irregular intervals are grouped as 'miscellaneous series' and are filed as such.

Internal loans during the year numbered 1,648, and 164 items were obtained on loan from other libraries at the request of members of staff.

PUBLICATION RECORD

- DUNN, J. A. (1954). *Micromus variegatus* Fabricius (Neuroptera) as a predator of the pea aphid. *Proc. R. Ent. Soc. Lond. (A)*, **29**, 76-80.
- FISHER, D. E. (1954). Internal infection of tomato seed by *Didymella lycopersici* Kleb. *Nature, Lond.*, **174**, 656.
- NELDER, J. A. (1954). A note on missing-plot values. *Biometrics*, **10**, 400-1.
- PHILP, J. (1954). The weed problem in vegetable production. *Proc. Brit. Weed Control Conf.*, 1953, 18-23.
- ROBERTS, H. A. (1954). Weeds of vegetable crops and their control. *N.A.A.S. Quart. Rev.*, No. 24, 139-45.
- WRIGHT, D. W. (1954). Cabbage root fly on summer cauliflowers. *Grower*, **41**, 293-9.

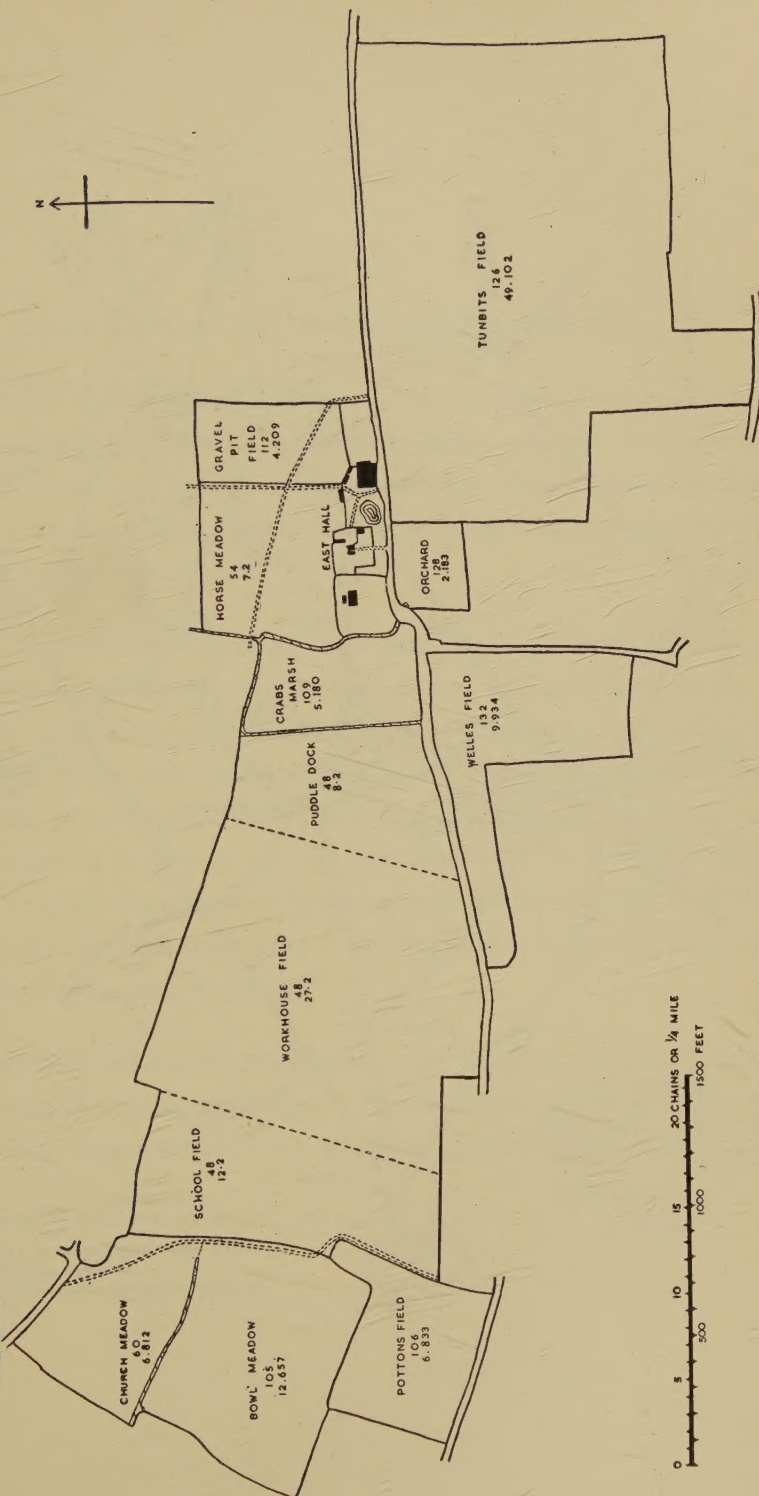
NATIONAL VEGETABLE
RESEARCH STATION
WELLESBOURNE
WARWICK



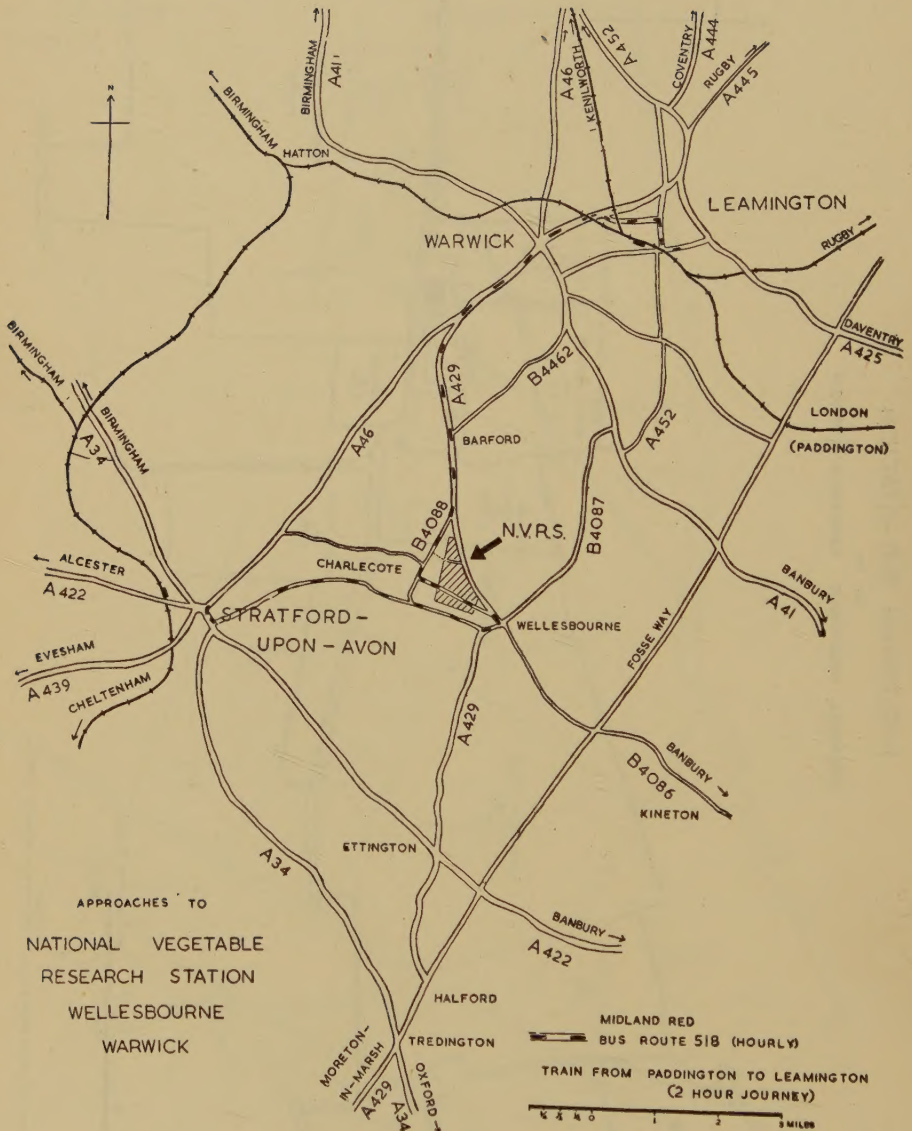
Based upon the Ordnance Survey Map with the sanction of the Controller of H.M. Stationery Office

PAGLESHAM SUB-STATION OF THE NATIONAL VEGETABLE RESEARCH STATION

PAGLESHAM



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THE JOURNAL OF HORTICULTURAL SCIENCE

The Journal of Horticultural Science, which is sponsored by the Long Ashton Research Station and the East Malling Research Station, welcomes contributions on horticultural science from Research Institutes at home or abroad. Papers for publication and all communications should be sent to the Editors at East Malling Research Station, Maidstone, Kent, England.

Papers in recent volumes and in the current Volume XXX describe work on fruit, vegetables and flowers. The subjects covered include cultural studies of strawberries, apples, pears (*e.g.*, stock-scion effects) and vegetable crops ; the effects of deficiencies of iron, zinc, copper, manganese, and molybdenum in various crops such as apple, broccoli, cacao, potato, strawberry and bulbs ; fruit storage ; the biology and control of pests of fruit and their predators ; the control of fungous diseases of fruit and tomatoes ; virus diseases of small and top fruits, including cacao, lime and hops ; low temperature injury ; genetical studies of fruits and vegetables ; artificial illumination ; soil sterilisation.

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